# TEACHER'S RESOURCE GUIDE
to accompany
# The Exploring Science Program
## BROWN BOOK (4)

by
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Bill Biles
Louise Steele



Doubleday Canada Limited
Toronto

Doubleday Australia
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Illustrated by Li-Wen Wang

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**SCOPE AND SEQUENCE CHART**

| YEAR | LIVING THINGS (Biological Sciences) | MATTER AND ENERGY (Physical Sciences) | THE EARTH AND SPACE (Earth-Space Sciences) |
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| **SCHOOL-WIDE PLAN**<br>DATE: ____________ | BIOLOGICAL | PHYSICAL | EARTH-SPACE |
|---|---|---|---|
| YEAR 1 | | | |
| YEAR 2 | | | |
| YEAR 3 | | | |
| YEAR 4 | | | |
| YEAR 5 | | | |
| YEAR 6 | | | |
| YEAR 7 | | | |

# TEACHERS' RESOURCE GUIDE
## to accompany
# The Exploring Science Program
## BROWN BOOK (4)

### PURPOSES

The two main purposes of the *Teacher's Resource Guide* to accompany *The Exploring Science Program—Brown Book (4)* are to:

1. provide you, the teacher, with some background information about the concepts, processes, and topics being developed in each unit.
2. suggest a wide variety of teaching strategies and learning activities for each unit, that complement, extend or reinforce the material presented in the textbook, and give you the resources to design a program that meets the needs of individual students.

### FEATURES

#### The Unit Overview

The Unit Overview consists of the following sections:

**Concept Development.** The main concepts of the unit are discussed in terms of how they are developed in the unit; how they were introduced and presented in the preceding units, and how the concept relates to child development.

**Process Development.** This feature describes the processes that are developed in the activities of the unit. It also includes some in-depth discussions of process skills that particularly relate to that unit.

**Related Units.** All units in the Exploring Science Program that further develop a concept, or that develop related concepts, are listed.

**Materials and Advance Planning.** Materials needed for a student, or a group of students, to carry out the activities, are listed. In some instances, suggestions are made for advance planning.

#### Background Information

The purpose of this feature is to provide you with additional information on the topics presented in the text. You may wish, at your discretion, to inject some of this additional information into class discussions.

#### Teaching Strategies

The Teaching Strategies include:

**Suggested activity, discussion, or research.** These suggestions are meant to extend, reinforce, or complement the concepts and processes presented in the text. They are interdisciplinary in nature.

**Worksheets.** These worksheets may be reproduced for use by individual students. They can be used to review or record material presented in the unit.

**Activity Cards.** The activity cards may be used in learning centres, or by individual students. They generally pose a question, or make a statement, that allows for further activity, investigation, discussion, or research.

# SCIENCE PLANNING OUTLINE

TEACHER ______________________ GRADE ______________________

| | BIOLOGICAL | PHYSICAL | EARTH-SPACE |
|---|---|---|---|
| SEPTEMBER | | | |
| OCTOBER | | | |
| NOVEMBER | | | |
| DECEMBER | | | |
| JANUARY | | | |
| FEBRUARY | | | |
| MARCH | | | |
| APRIL | | | |
| MAY | | | |
| JUNE | | | |

# BROWN BOOK (4)

# Unit 1: Plant Growth and Behaviour

**Pages 6-47**

## UNIT OVERVIEW

### Concept Development

In the preceding levels of the program, the following concepts were introduced and developed:

There are many kinds of living things. Living things differ from nonliving things in that they grow and change; need food, air, water and proper temperatures; reproduce their own kind; respond to stimuli, and adapt to the environment which they inhabit. The two broad groups of living things are the plant and animal kingdoms. Plants differ from animals in that they generally make their own food and do not move from place to place.

Seed plants were also discussed. Plants that grow from seeds are called seed plants. They are important as a source of food for animals, for other by-products used by people, and for their beauty. The seed is made up of the young plant (embryo), a food supply, and a protective coat. The embryo within the seed has two parts, one of which becomes the roots and the other the stem and leaves. Germination of a seed, depends on the availability of food, oxygen, suitable temperature, and water. The structure of a seed plant enables it to carry out its life functions. There are four main parts — the root system, stem, leaves and flowers.

This unit develops the concepts that within the plant kingdom, groups of plants have characteristic *structures and functions, behaviour* and *patterns of adaptation* to their environment, which enable them to carry out their life functions. Plants are also continually *interacting* with other living things and the physical environment.

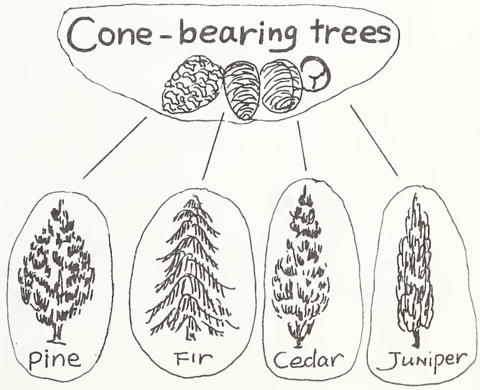
"Plant Growth and Behaviour", consists of three chapters. Chapter one discusses the concept of *plant reproduction*—that new plants generally grow from seeds, spores, or by fragmentation (vegetative reproduction). Students are then introduced to the concept of the cell—the basic building block of life. They learn that plants are made up of cells, and that plants grow by means of cell division. Another concept discussed in Chapter one, is that there are certain *environmental factors* that are required in order for germination to take place. Chapter two introduces students to the concept of plant responses to the physical environment. These responses are called *tropisms*. Plants have developed systems that allow them to respond to both non-living and living things in the environment. These are discussed in Chapter three. Living things may gain, or they may be adversely affected, by these interactions.

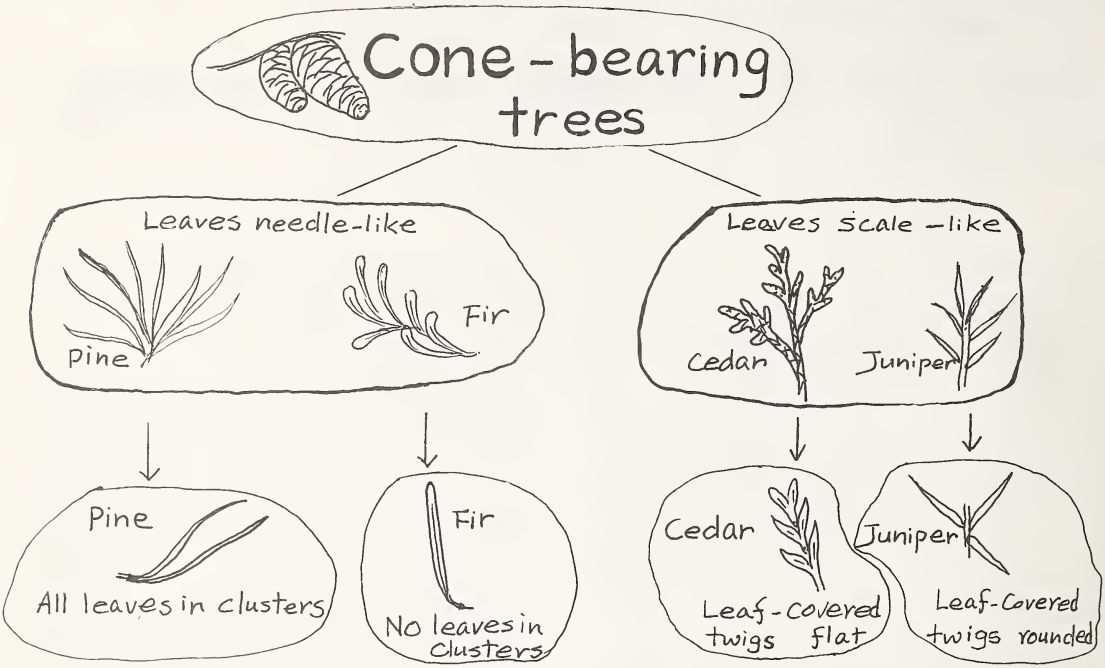
### Process Development

The material considered in this unit offers opportunities for students to participate directly in many different processes and activities that introduce, complement, reinforce, or extend the concepts that are being developed. Students *observe* the properties and characteristics of different sprouting seeds and spore-forming ferns. They use these observations to make *comparisons* and to construct *classification* schemes. Students then *investigate* whether new plants can be grown from cuttings. They attempt to *identify* and *control variables* that might affect vegetative reproduction. Students then *observe* some tropisms of plants in the next activities. They use their observations to make *inferences* about tropisms. Students also *observe* an animal-eating plant and they *predict* the plant's reaction to different foods.

Throughout the unit, students *describe* the structures and conditions *observed*, and *communicate* possible interpretations in writing, representationally or orally.

For the classification activities, students at this level should be able to understand and to do a multi-stage classification. Classification is a sorting process designed to show the similarities, differences and interrelationships of the elements in a collection of things. The sorting is based on observable characteristics and divides the collection into subsets that are more homogeneous than the collection. When the classification results in two subsets, it is called a single stage classification system. For example:






When the first stage requires further sorting, a new distinguishing characteristic is used to sort the subsets into smaller subsets. This is called a multi-stage classification system.

### Related Units

Living Things *Orange Book (1)*
Environment *Gold Book (2)*
Seed Plants *Blue Book (3)*
Small Living Things *Green Book (5)*
Plant and Animal Life Cycles *Red Book (6)*
Biology: The Study of Living Things *Exploring Living Things*

### Materials and Advance Planning

The following list includes the materials that a pupil, or in some cases a group of pupils, will need to carry out the "Find Out" activities. In some instances, other materials may be substituted for those on the list. About 14 seeds such as corn, peas, or beans; paper towels; saucer; fern leaves collected in late summer or early fall; hand lens; 2 coleus or geranium plants in pots; 4 bean seeds; 2 small, flat pieces of glass; tray of water; 2 small rocks; 2 small plants (grown from the bean seeds); 2 cardboard boxes; long plastic or glass dish; potting soil, sand; gravel; black paper; wide-mouthed glass jar; peat moss; Venus's-flytrap seeds (or plant); small piece of raw hamburger beef.

Check with your local nursery or science supply house to see if the coleus, geranium and Venus's-flytrap plants are available. You may wish to substitute a pitcher plant for the Venus's-flytrap.

You may wish to collect the fertile fern fronds in late summer or early fall and press them in a plant press or between newspapers under heavy books. The newspaper should be changed each day. The fronds will then be available for when you need them.

## BACKGROUND INFORMATION

### Chapter 1: Plant beginnings, pages 8-21

Plants exist in a diversity of form, size and colour, and have adapted to living in a variety of terrestrial environments. There are, for example, over 250 000 species of seed plants which vary in size from the minute duckweed plants, to plants like the Douglas-fir trees, with diameters of up to 4 m and heights of up to 90 m. Yet all these seed plants show basic similarities in their internal structure and the functions they perform in order to live and reproduce.

Plants can be classified according to how they reproduce. Many plants reproduce from seeds. Seed plants can be divided into two kinds—the angiosperms, or flower-producing plants, and the gymnosperms, or cone-producing plants. Other plants reproduce from spores. Examples of spore-producing plants are ferns, mosses and mushrooms.

The basic building block of plants is the cell, whose main parts are the nucleus, cytoplasm and cell wall. Cells are complex in structure. Cells reproduce by a process called mitosis (a process whereby one cell divides, forming two new identical cells).

Cells in the leaves of green plants make food by a process called photosynthesis. The cells need four things in order to make food. These are water, carbon

dioxide, chlorophyll, and light. The chlorophyll enables the cells to use the energy from sunlight to change carbon dioxide and water into sugar. The sugar is used by plants for food. A valuable by-product of photosynthesis is oxygen, which is released by the leaf to the air.

Another function of certain cells in plants is to store food. The sugars are converted into starch, which is stored in the plant as a future source of energy. Animal life on earth would not be possible without green, leaf-bearing, food-manufacturing plants. Their importance to life is a concept that should be stressed with students.

In order for seeds or spores to germinate, or sprout, they need the proper amount of air, warmth and moisture. During germination they use their own stored food as a source of energy, thus light is not a requirement for germination. However, after germination, the plants begin to produce their own food, and the availability of light energy becomes a crucial environmental factor.

The cells of some spore-producing plants, do not contain chlorophyll and therefore cannot carry out photosynthesis. As a result, plants such as mushrooms, must feed off other living or nonliving organisms in order to obtain food needed for survival.

Thus, the *importance* of green plants as primary producers of food; how the *structure* of a plant enables it to carry out its *life functions*, and the *interrelationship* between environmental factors and plant growth, are concepts that need to be stressed in this chapter.

### Chapter 2: Plant behaviour and nonliving things, pages 22-29

This chapter develops the concept that there are certain factors in a plant's structure that enable it to react to external environmental factors.

These internal chemical regulators (auxins) cause plants to be sensitive to light, gravity or water. The responses plants have to these factors are called *tropisms*. ("Tropism" is derived from a Greek word meaning "turn").

*Geotropism* refers to the response a plant has to gravity (the prefix "geo" means the earth). For example, the root of a seedling usually reponds to gravity by growing toward the centre of the earth. This is referred to as positive geotropism. The stem of the seedling, however, usually grows in the opposite direction, or away from the force of gravity. This is called negative geotropism.

*Phototropism* refers to the response of a plant to light. (The prefix "photo" means light or radiant energy). Plants generally grow toward light. This is called positive phototropism. Some plants, such as the English ivy, turn away from the light and display negative phototropism. Certain other plants display both positive and negative phototropism. They will turn toward light when the amount of light is low and turn away from the light when the amount of light is high.

Another form of tropism displayed by plants is *hydrotropism*. (The prefix "hydro" means water). This response is displayed by the roots of plants as they grow toward moisture in the soil.

The chemical substances that cause tropisms are called *auxins*. Auxin generally flows from cell to cell within the stem or root to the region just behind the tip. Auxins cause cells to grow more rapidly. By making some cells grow more quickly than others, the auxins can cause a response in the plant such as geotropism. For example, if a stem is growing horizontally, auxins will concentrate in the cells along the bottom of that stem. This causes the cells along the bottom of the stem to grow more rapidly than those along the top. As a result, the stem turns upwards away from gravity.

The important concept to stress in this chapter is the *relationship of the structure* of a living thing *to the way it behaves, responds* and *functions* in its physical environment.

### Chapter 3: Plant behaviour and living things, pages 30-43

In addition to responses to nonliving things in the environment, plants have developed systems that allow them to respond to other living things in the environment.

The mimosa plant, for example, has a *defense mechanism*. When one leaf is touched, all the leaves fold within two or three seconds. The folding of the leaves is caused by a sudden decrease in pressure of some specialized cells at the base of the petiole, or the tiny stem that attaches the leaf to the rest of the plant. The decrease in pressure is thought to be due to a decrease in the amount of sodium being sent to the leaves, when the plant is touched. The decrease in sodium then decreases the amount of water entering the leaves, thus causing the leaves to fold.

Some plants have responses that enable them to trap living things in order to obtain the nutrients they need for growth. The Venus's flytrap, for example, has three sensitive hairs on each half of each leaf. When at least two hairs are touched in succession, or one hair is touched twice, the leaf will close over the plant's prey. The leaf squeezes the insect, or other prey, and secretes digestive juices over the body of the prey. The pitcher plant has a leaf structure that enables it to catch rain water. Insects are lured to the pitcher plant by a distinctive odour and by some nectar near the rim of the pitcher. Insects find it difficult to crawl out because of the slipperiness of the leaf and some obstructing leaf hairs.

Interaction between different species of plants or with animals result in many interesting behaviours and responses. For example, a plant may be adversely affected by the presence of another in its search for water, nutrients, light or space. This interaction is called *competition*. A common example of competition occurs between such plants as dandelions and grasses.

When two or more species of plants or animals gain from the association or interaction, the relationship is called *protocooperation*. An example of protocoopera-

tion is that of a bee and a flowering plant. The bee obtains nectar from the flower and, in return, carries the pollen that is required for fertilization to other flowers.

The concept that this chapter stresses is that in the *interactions* between plants and living things, plants have *patterns of adaptation* that enable them to carry out their *life functions*.

## TEACHING STRATEGIES

The purpose of the following activities and teaching strategies is to provide you, the teacher, with a wide variety of suggestions that can be used, together with the material presented in the textbook, to help guide your students in developing the processes and concepts of this unit.

### Chapter 1: Plant beginnings, pages 8-21

#### Plant Hunt

— You may wish to begin this chapter by carrying out the suggested activity on page 9 of the Teacher's Edition—a walk through the schoolground or a neighbourhood park to *observe* the diversity of plant life in a given area. This activity develops the skills of *observing* and *identifying similarities and differences* in plants. It can also be used to develop the *classification* skills of your students.

— You may wish to have your students use Activity Card 1 to record and group the plants that they find on the plant hunt.

#### Seeds and spores (pages 8-13)

— Ask students to study pages 8 to 13, and find the answers to the following questions:

1. What are spores?
2. How do spores differ from seeds?

#### "Finding Out" (page 11)

#### How can you find the parts of sprouting seeds?

— You may wish to have your students do Activity 1 in their Activity Books (Textbook page 11).

*Processes used and sample findings:*

— *Observation Skills.* Students will observe the *qualitative* properties of the sprouting seeds—that a seed consists of a seed coat, seed leaves (cotyledons), the root, and the shoot (embryo).

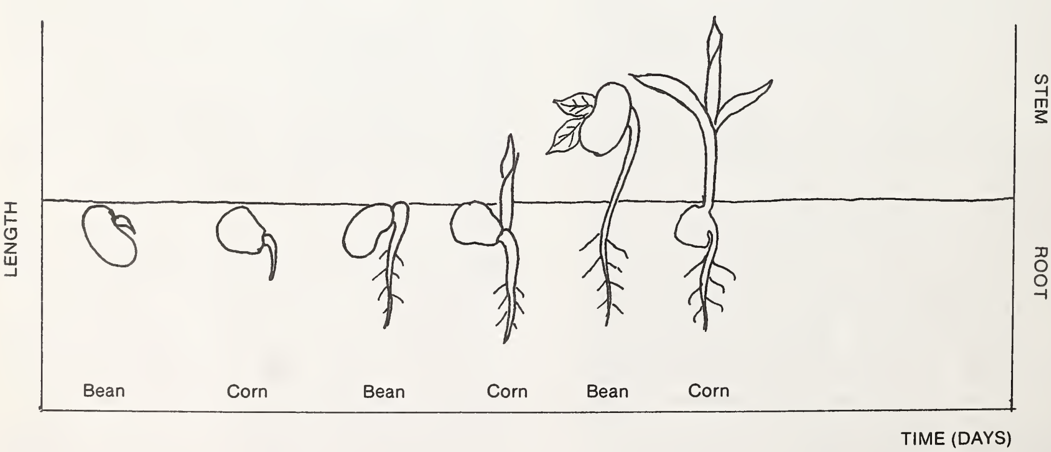
Students will also observe *quantitative* properties of sprouting seeds—that beans have two seed leaves and corn has one seed leaf; that the roots appear first; that over time, the stem, roots, and leaves grow, and the seed leaves (cotyledons) shrink. You may wish to have students carry out their observations representationally by completing Worksheet 3. The diagram below indicates how the sprouting seeds should look.

— *Comparison Skills.* Students will be comparing seeds such as the bean, with two seed leaves (dicotyledons) with seeds such as corn, with one seed leaf (monocotyledons). They will be comparing similarities and differences.

Bean seeds will sprout first. Roots break out in the form of an arch, which then starts to grow down, and the arch straightens. The two seed leaves are pushed up and the cotyledons separate. Between the cotyledons are the embryo stem and the first leaves.

With the corn seeds, the roots emerge first and they grow straight down. Then a spear-like sheath emerges that encloses the first leaves. The seed leaf will not be lifted up as it was with the bean seed.

— *Classification Skills.* Students should classify the sprouting seeds as seeds with one seed leaf (monocotyledons) or seeds with two seed leaves (dicotyledons).



"Finding Out" (page 12)

What do the spore-forming parts of ferns look like?

— You may wish to have your students carry out Activity 2 in their Activity Books (the "Finding Out" on page 12).

*Processes used and sample findings:*

— *Observation Skills.* Students will be observing the positions and patterns of the spore cases. Some spores form borders along the edges of the fronds. Others form two lines on the undersurface of the frond. Students will also observe that the spores are numerous and are very small. Some spore-forming parts are circular or oval-shaped; others are linear.

— *Inference Skills.* You may wish to ask your students why the fern needs to produce such a large number of ferns. Students may infer that because the spores have very little stored food and no protective covering, that the chances of survival are small. Large numbers ensure that some fronds will grow.

— *Comparison Skills.* Students will be comparing the position, patterns and shapes of the ferns. You may wish to have students identify their ferns from a classification chart or field guide.

— *Communication Skills.* You may wish to have students display their observations and comparisons on a diagram or print of the fern. Prints can be made in a number of ways:

  — Take a piece of thin paper and fold it over the fern. Rub the upper surface all over with a wax crayon, shoe polish, linseed oil or charcoal.

  — Place the fern on a piece of ozalid or other photosensitive paper, between a piece of cardboard and glass. Expose this to sunlight for a short while. Develop the paper according to the type used.

  Students could also name the fern, giving the date and place of finding.

Plant cells and growth (pages 14-16)

— The information on pages 14-16 can be read and discussed.

— Modelling models are a useful way for building a mental or abstract awareness of an object or event that is difficult to observe directly. After discussing "What are plant cells like?" you may wish to have students make model cells.

  Here are two suggested ways to make cell models:

  1. Heavy string (butcher twine) is soaked in bondfast to make cell walls. The string is shaped and stuck on to a heavy cardboard surface. Coloured paper can be glued on to show the nucleus and chloroplasts.
  2. Small clear boxes (such as the ones used for straight pins) can be used. Plasticene of the appropriate colours can be used for the nucleus, chloroplasts, cytoplasm and cell wall.

— You may wish to extend this activity by asking students to make models showing cell division. They may wish to refer to page 16 of the textbook.

Food record (page 17)

— Page 17 could be read and discussed.

— Students could be asked to keep a record of all the vegetables and fruits that they eat over a period of a week. These could be *classified* on Worksheet 2 according to the part of the plant which supplied the food.

— At the end of the week, this information could be used to have a class discussion about the nutritional importance of vegetables and fruits in a daily diet.

— Create a Dish! Students could be asked to create a salad or vegetable dish.

  Divide your class into four groups. Ask:

  1. Group 1 to create a dish with root foods.
  2. Group 2 to create a dish with leaf foods.
  3. Group 3 to create a dish with stem foods.
  4. Group 4 to create a dish with fruit foods.

  These foods could then be sampled by all the students.

Making seeds and spores sprout (pages 18-20)

— After reading and discussing pages 18-20, you may wish to have your students devise their own *experiment* to show that seeds and spores need water, air, and warmth to sprout.

— Students should use one type of seed and should set up their experiments in ways that *identify* and *control the variables*. For example:

  Container 1: Seeds are planted in soil, with a source of moisture, warmth, light and air.
  Container 2: Same as #1, but the container is kept in a dark place.
  Container 3: Same as #1, but the container is kept in a cold place.
  Container 4: Same as #1, but the container is kept without moisture.
  Container 5: Same as #1, but the seeds are planted at different depths.
  Container 6: Same as #1, but the seeds are placed in a different medium.

"Finding Out" (page 21)

How can you grow plants from parts other than seeds and spores?

— You may wish to have your students complete Activity 3 in their Activity Books ("Finding Out" on page 21 in the text).

*Processes used and sample findings:*

— *Observation Skills.* Students will observe that the plant grew new roots from its lower end, and it grew new leaves from its upper end.

— *Inference Skills.* Students will infer from their observations that some plants are able to grow a whole plant from other parts.

— *Experimentation Skills.* After completing this activity, you may wish to experiment with growing plants from parts other than seeds or spores. The experiment may be thought of as integrated process skill,

as it involves many of the process skills of science.

—*Experimentation* is the process of designing and carrying out procedures in order to obtain reliable information about interrelationships between objects and events. Discuss with your students the procedures for an experiment:

1. Given a testable *hypothesis*—other plants can grow from parts other than seeds or spores.
2. Students identify the *variables* (things or conditions in a system which may influence it) (a) part of the plant used (part of a root; a leaf; a stem; the top of the plant); (b) the growing medium (soil, sand, water) and (c) environmental factors (moisture, light, warmth, air).
3. Students *establish procedures* to control variables, to carry out the investigation and to *collect data*.
4. The experiment *is carried out* and *data is collected*.
5. Students *interpret* their data from a given set of observations.

Students could try to grow: tulips or lilies (bulbs are specialized stems); potatoes (the eyes or buds are on an underground stem); leaves of African violets, geraniums or begonias (the leaf stalk, not the leaf, should be touching water or should be in moist sand); runners of plants like the strawberry; leaves that have several cuts on the larger veins on the underside (press the leaf onto moist sand with pebbles), or parts of roots (carrots, turnips, beets)

### Extension activities for Chapter 1

—You may wish to consider the following extension activities that can be done when this chapter has been completed:

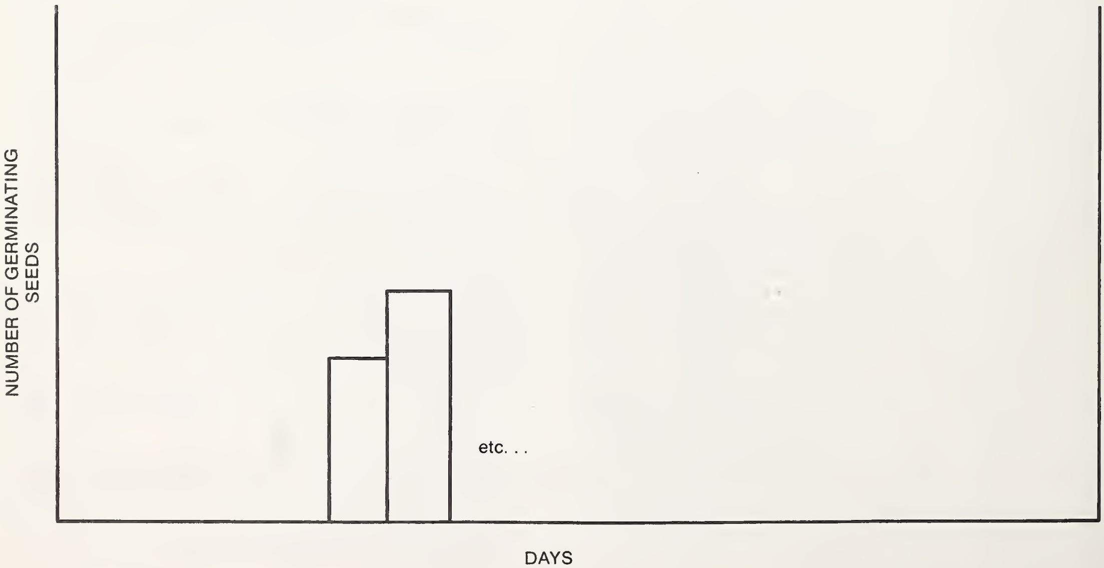
1. Start a Garden. Students could make their own gardens, using boxes or cartons lined with plastic to prevent leaking. You may also wish to set aside a small portion of the schoolground and begin a school vegetable patch.
2. Germination Percentage and Rate. You may wish to have students place 100 seeds of one kind in a large tray of damp soil. The tray should be at room temperature and should be covered with plastic. Students could record their observations on a bar graph.

After a period of days, students could calculate the percentage germination from the number of seeds that germinated.

This activity could be repeated by using the same type of seed, but different brand names, to compare germination rate and percentage for the different name brands.

3. Fern Growth. You may wish to have your students grow their own ferns from spores that were collected in the fall. The frond could be placed on moist peat moss, spore cases facing down, covered, and left in a cool, shady place. The soil should be kept moist. After a period of time, a green tinge should appear. The frond can now be removed.

   Students could use these young ferns to experiment with conditions necessary for the growth of ferns.
4. Parent's Day Present. You may wish to have your students grow begonias, geraniums or other plants from leaf or stem cuttings. They could also make a pot out of clay or a macrame hanger. When the cuttings have taken, they could be planted in an arrangement in the pot and could be given to their parents as a Mother's Day or Father's Day present.



## Chapter 2: Plant behaviour and nonliving things, pages 22-29

**Note making:** Notes in science are a verbal method of compiling observations and transmitting ideas.

As students study the material in this chapter, you may wish to have students develop notes on the response of plants to gravity, light and moisture.
Each topic should have:
— a descriptive title or key heading,
— Notes based on discussions, reading, activities and investigations.

**Word Pictures** You may wish to apply the concept of the relationship of structure and function to words. The object is to relate the shape or appearance of the word to the meaning. Ask students to choose words from the chapter and "make the words do what they say". For example:


— The word pictures could be displayed on a classroom or hallway bulletin board.

### "Finding Out", page 23
### Can you make the parts of the seed grow in the wrong direction?

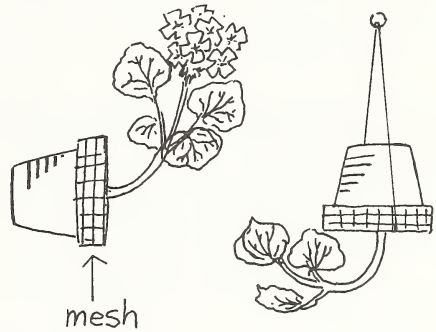
— You may wish to have your students complete Activity 4 in their Activity Books (Textbook page 23).

*Processes used and sample findings:*

— *Observation Skills.* Students will observe that the roots of the seeds which were planted upside down or sideways, will turn around to grow downwards. Students will observe that the stems of the seeds that were upside down or sideways will turn around to grow upwards.
— *Comparison Skills.* Students will compare the direction of growth of the stem and root.
— *Inference Skills.* From their observations, students may infer that because roots always grow downward, stems will always grow upward. Others may infer that roots grow downward because they require water and minerals from the soil and that stems grow upward because they require air and light.
— *Communication Skills.* You may wish to have students communicate their results representationally. They could use a grease pencil to mark on the glass the change in direction of growth.

### Extension activity (page 23)

— You may wish to demonstrate geotropism by using the two potted geraniums or coleus plants used in the "Finding Out" on page 21.
— Place screening over the top of the pots. Lay one pot on its side, and hang one upside down.
— Have students observe the behaviour of the plant stems over a period of a few days.




### "Finding Out" (page 27)
### How can you show that plants grow toward light?

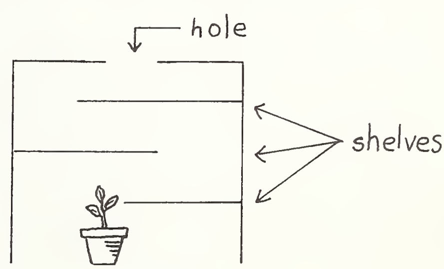
— You may wish to have your students complete Activity 5 in their Activity Books (Textbook page 27).

*Processes used and sample findings:*

— *Observation Skills.* Students will observe that the stem and leaves of the plant will bend toward the light. When the boxes are switched, students will observe that the plant makes a further adjustment in order to grow toward the light.
— *Comparison Skills.* Students will compare the direction of growth of the stems of the two plants.

### Extension activity (page 27)

— You may wish to have your students devise other "light" boxes after they have completed the "Finding Out" on page 27. Holes of different sizes and heights could be placed in the boxes.
— One suggested design is illustrated below.




— Have students predict the direction that the stem will grow and then have them test their predictions.

### "Finding Out" (page 28)
### How can you show that roots grow toward water?

— You may wish to have your students complete Activity 6 in their Activity Books (Textbook page 28).

*Processes used and sample findings:*
—*Observation Skills.* Students will observe that the roots have grown toward the moist end of the container.
—*Inference Skills.* From their observations, students may infer that whenever a little water reaches the roots from any direction, the roots are then stimulated by a chemical substance to grow in the direction of the source of water.

**Variables** You may wish to have students consider additional variables in the "Finding Outs" on pages 23, 27 and 28. For example:
1. Use different varieties of plants. Are some plant varieties affected more quickly than others?
2. Use plants of different ages. Do younger plants react to light, water and gravity more quickly than older plants?

**People Tropisms.** At the completion of this chapter, you may wish to carry out a class or school survey to find out how people react to some environmental factors in their physical environment.
—Some of the factors they could consider are: heat, cold, wind, rain, dark, light, thunder, lightning.
—Discuss with your students the importance of: well-worded questions, not displaying bias and having an efficient data-collecting system.
—You may wish to discuss some of the responses in a class discussion.

### Chapter 3: Plant behaviour and living things, pages 30-43

**Group Research** You may wish to divide students into groups and assign each group a topic. Examples of topics that could be used are:

Animal-eating plants
How plants protect themselves
Using plants to control garden pests
Plants and animals that help each other

Each group would be responsible for researching their topic, for locating and selecting books, films and filmstrips on the topic and for preparing a study centre on the topic that could be used by other students in the room or school. The study centre could include an information panel, filmstrips, books, pictures, activity cards and games for students to use.

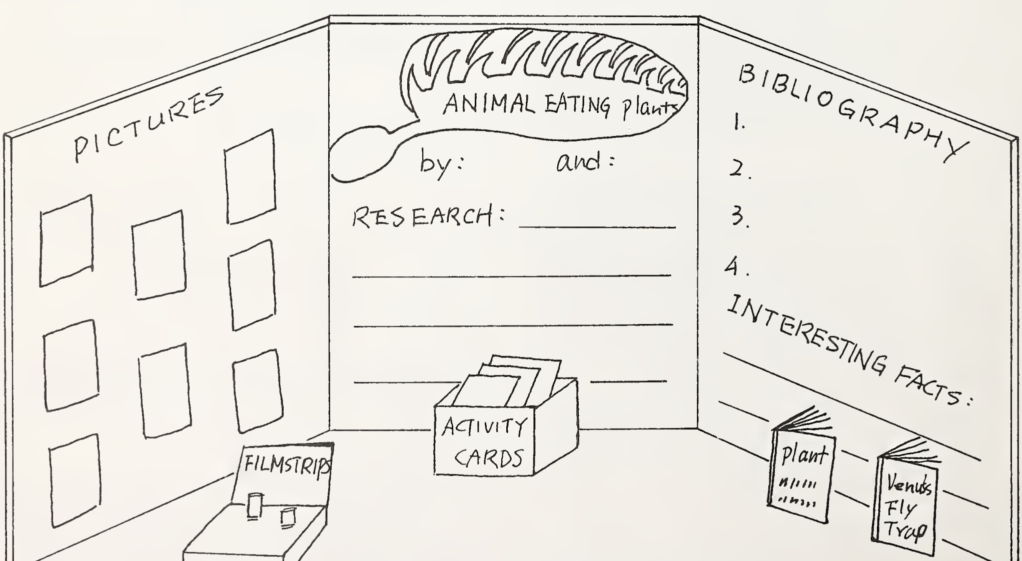
You may wish to evaluate the research project according to how well the topic was researched, the content, the presentation of the study centre and how well the group members shared responsibilities for the project.

**Overcrowding**

—After students have read and discussed pages 30 and 31, you may wish to have them do Worksheet 3 to demonstrate how overcrowding affects plant growth.

**"Finding Out" (page 38)**
**Do some plants really eat animals?**

—You may wish to have your students complete Activity 7 in their Activity Books (Textbook page 38).
*Processes used and sample findings:*
—*Observation Skills.* Students will observe that the leaves of the Venus's flytrap will close around the paper and the hamburger. However, they will observe



that the leaf which closed around the paper will open again the next day, whereas the leaf which closed around the hamburger, will not open again for over a week. They will observe that the hamburger looks shrivelled, whereas there was little change to the paper.

— *Measurement Skills.* The students will measure the length of time that it takes for the leaves to open up again.

— *Comparison Skills.* Students will be comparing the plants reaction to two different objects—paper and hamburger.

— *Inference Skills.* From their observations, students will most likely infer that the plant digested and used most of the nutrients in the hamburger, but did not find nutrients that it could use in the paper.

— *Prediction Skills.* Students will predict that when a fly is placed on the leaf, it will probably get caught inside the leaf. They will further predict that the leaf will digest most of the fly and the leaf will open again after more than a week.

— *Experimentation Skills.* You may wish to have the students test their predictions by asking them to place a fly, or other living object, on the leaf of a Venus's flytrap.

School Vegetable Patch

— After studying page 42 and 43 in the textbook, you may wish to have students start a vegetable patch that uses other plants for the natural control of pests.

— For example, the vegetable could be encircled by marigolds and nasturtiums. A row of onion plants could be planted next to a row of carrot plants. Asparagus plants could be planted near tomato plants.

Super plant After completing this chapter, you may wish to ask your students to design a plant.

— The plant they design should have structures and behaviours that will enable it to survive with other living things. Some examples are:

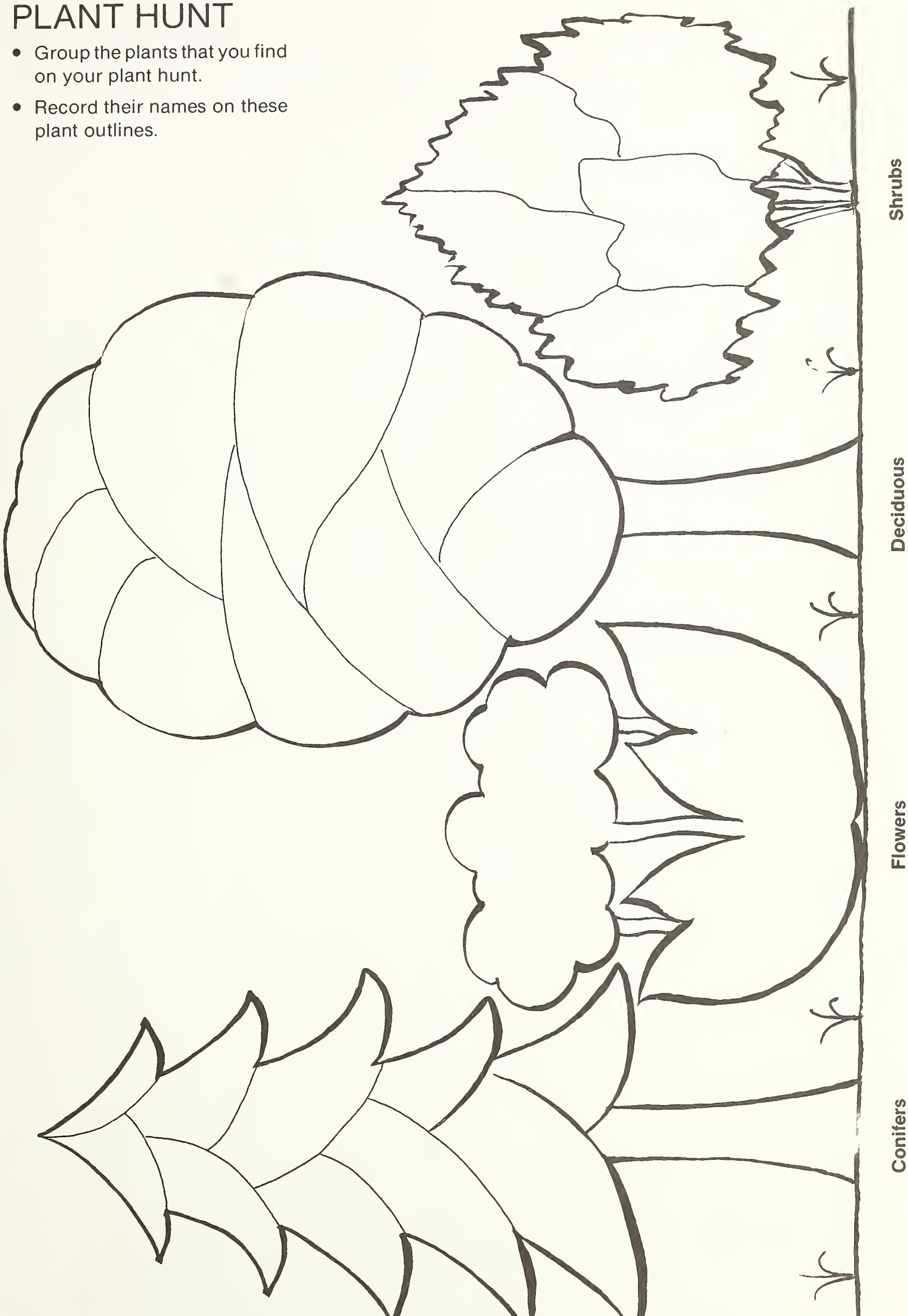
— Design a super plant: (choose one)
  — that grazing animals won't eat
  — that will attract insects for pollen
  — to catch insects
  — that can compete with other plants for sunlight.

— Students could draw or make a model of their super plant. They could also give it a name.

— Assessment could be based on originality and on the level of understanding that the student displays in applying the concepts of this chapter.

# PLANT HUNT

- Group the plants that you find on your plant hunt.
- Record their names on these plant outlines.




Plant Growth and Behaviour, Activity Card 1

# Sprouting seeds

- Sprout bean and corn seeds following the instructions given in the "Finding Out" (page 11): How can you find the parts of sprouting seeds?
- Record your observations on the chart by drawing the seed as it sprouts.

STEM

ROOT

CORN

BEAN

CORN

BEAN

CORN

BEAN

CORN

BEAN

DATE

LENGTH

# FRUIT AND VEGETABLE RECORD

- List all the fruits and vegetables that you eat for a period of 7 days.
- Check off the part of the plant that you ate.
- Also show the number of times that you ate a particular plant or vegetable during the week.

| NAME OF FRUIT OR VEGETABLE | ROOTS | STEM | LEAVES | FRUIT |
|---|---|---|---|---|
| | | | | |

# Overcrowding

You will need: seeds (wheat, rye or clover), 3 containers, soil

Plants need light, water and nutrients from the soil. How does overcrowding affect plant growth?

- Put some soil in each container.
- Plant the same kind of seeds in all three containers.
- In the first container, the seeds should be very close to each other.
- In the second container, space the seeds 5 mm apart.
- In the third container, the seeds should be spaced 5 cm apart.
- Place the three containers where they will receive equal sunlight and water them regularly with the same amount of water.
- Observe the containers at regular intervals for 2 or 3 weeks.
- Each time you observe the growth of the plants in the containers, pull up one plant from each container. Use tape to attach the plant to the graph on the following page.

What differences did you observe among the plants growing in the containers?

From your observations, what do you think caused these differences?

# Overcrowding

STEMS AND LEAVES

SOIL LEVEL

ROOT

CONTAINER

1 2 3 — DAY 5

1 2 3 — DAY 4

1 2 3 — DAY 3

1 2 3 — DAY 2

1 2 3 — DAY 1

LENGTH

Plant Growth and Behaviour, Worksheet 3 (Cont'd)

# BROWN BOOK (4)
# Unit 2: Animals and their Environment
**Pages 48-95**

## UNIT OVERVIEW

### Concept Development

In the preceding levels of the program, the following concepts were introduced and developed:

There are many kinds and forms of living things. Some of the characteristics that distinguish living things from nonliving things are that they grow and change, they reproduce their kind, they use food for energy, they breathe, they respond to stimuli and they adapt to the environment they inhabit. This unit develops the concepts of change, adaptation and interaction. It is designed to help students realize that living things are continually *interacting*, *adapting* and *changing*. They will also begin to understand the delicate balance that exists in the environment and the important role that each of us plays in maintaining and protecting this balance.

Unit 2, "Animals and Their Environment", consists of four chapters. Chapter one explores the world of dinosaurs with emphasis on where and how they lived, reasons for their extinction, and methods used for collecting data about dinosaurs. Chapter two illustrates how certain animals have become especially adapted to their environment. Various protective mechanisms animals use to survive within their environment are outlined in the third chapter. Chapter four discusses reasons why some living things are endangered, and then considers some conservation techniques. The unit ends up considering what individuals can do to help protect living things.

### Process Development

The first part of the unit lends itself to developing an understanding of how *inferences* are made based on *observations of indirect evidence*. The importance of not jumping to conclusions, of looking for reliable evidence and of considering conclusions as tentative, can also be stressed.

In the other activities in this unit, students will be able to *observe* and *describe* structural and behavioural adaptations of some living things, *identify* and *control variables* when investigating overpopulation, *collect and record* data on some adaptations, make *inferences and comparisons* about adaptations of living things to the environment and *communicate* possible interpretations. There are also opportunities to develop *scientific attitudes* towards environmental problems and to use *research skills*.

### Related Units

Living Things *Orange Book (1)*
Environment *Gold Book (2)*
Animal Behaviour *Blue Book (3)*
Ecosystem Earth *Red Book (6)*
Ecology—Interaction in the Environment *Exploring Living Things (7)*
Biology—The Study of Living Things *Exploring Living Things (7)*

### Materials and Advance Planning

Flat pan, soil, small objects such as a chicken bone or leaf, 2 or 3 frogs, newts or salamanders and food for them (mealworms, worms, brine shrimp, etc...), small aquariums or suitable clear containers, rocks, pebbles, coloured toothpicks (be sure that some are green), about 24 mealworms, natural bran, lettuce, 4 glass jars.

Contact your local pet store or a biological Supply House to see if the animals listed above are available. If not, ask for suitable alternative animals.

Make provisions at the end of the unit to return all living things to their environment.

## BACKGROUND INFORMATION

### Chapter 1: Where have all the dinosaurs gone?, pages 50-57

The concept that everything in the universe is continually changing is a very important one. The face of the earth changes and with it the kinds of living things that live on it. These changes generally occur very slowly. Indeed, the few thousand years of recorded history are but a moment in the total time sequence of the earth's history. The slowness of change and immensity of the time sequence are difficult concepts for students at this level to grasp unless they are presented in some illustrative or comparative way.

One such way is to think of one year representing the geological time of the earth. The arrival of early people would be a few hours before midnight on December 31st. Another way would be to give small groups of students a five metre length of adding machine tape. Allowing each metre to represent one billion years, have them highlight and label important events in the earth's history.

Records about past life and conditions on the earth can be found in the evidence left in rocks as fossils. Fossils tell us many things. When studied in relation to rock formations, they reveal the sequence of life. Fossil seashells found in the Rockies indicate that they were once covered by the sea. Fossil ferns found in the Arctic would suggest that the Arctic climate was much warmer at one stage in the past. Fossil remains also tell us that some living things were unable to adapt to change and are now extinct. The dinosaurs were one such group of animals.

Dinosaurs developed in the Mesozoic (middle life) era, which began about 225 million years ago and ended about 65 million years ago. This era is also known as the age of the reptiles. A great many varieties of reptiles developed during the Mesozoic era, but the stars of the early reptiles were the dinosaurs.

There were two main types of dinosaurs. One had a lizard-hipped pelvis similar to that of the present-day lizard. The other had a bird-hipped pelvis.

Some of the lizard-hipped dinosaurs were herbivorous, or plant-eating, while others were carnivorous, or meat-eating animals. The ruler of them all was the Tyrannosaurus rex, 15 m long and 6 m tall when it stood erect on its hind legs. This carnivore had a head that was 120 cm long, with a huge mouth and 15 cm long teeth projecting from the jaw. Brontosaurus was another huge dinosaur. It measured 24 m in length, with a mass of 27 000 kg. Compared to Tyrannosaurus, it had a small head, a long, slim neck and it walked on all fours.

The bird-hipped dinosaurs were all herbivores. Many were covered with bony plates that protected these dinosaurs from the meat-eating dinosaurs. Triceratops, for example, had a bony shield extending back from its 220 cm head, with a 1 m long horn over each of its eyes and a third, shorter horn over its nose.

Dinosaurs were remarkably successful for millions of years. Then suddenly, in terms of geological time, they became extinct. The reasons for their extinction offer an opportunity to develop the concept of the delicate balance that exists in an environment. A change in one part of an environmental system, will require that the other interacting parts change and adapt. Many examples of changes, both natural and made by people, can be found all around us.

Many scientists believe that during the latter part of the Mesozoic era, there was a climatic change, resulting in a colder and drier environment than before. This change in climate killed off many of the plants that the herbivorous dinosaurs used for food. The herbivorous dinosaur population started decreasing. As a result, the carnivorous dinosaurs, which preyed on the herbivores, could not get enough food to survive.

The drier climate also caused the swamps to dry out. Many dinosaurs lived in swamp water because their bodies were too huge for them to support their mass when on land. Other smaller animals were able to move about on land and compete for food.

Although scientists do not know for certain, they suggest that the demise of the dinosaurs was probably the result of a combination of factors, rather than a single factor.

### Chapter 2: How are animals suited to where they live?, pages 58-68

Life exists almost everywhere on earth. Regardless of where organisms live, they all have certain *adaptations* that make them especially suited to the environmental factors, such as temperature, availability of water and topography, that exist in their particular environment.

This chapter considers how certain animals have become especially adapted to their environment. These adaptations may be *external*—ways of moving, obtaining food or protecting internal systems, or *internal*—adaptations to the respiratory, digestive or reproductive systems of the organism. Animals which live in a desert, polar, mountain, water or water and land environment are discussed.

Desert animals are generally small. Their small size allows them to find shelter from the high daytime temperatures and also enables them to survive with less food than larger animals. External adaptations such as large tails or large ears in proportion to body size, help certain desert animals rid themselves of excessive body heat. The kangaroo rat and the cacomistle are examples of animals with large tails, and the mule deer and the antelope jackrabbit are desert animals with large ears.

In comparison, polar region animals such as the ermine and Arctic fox have very small ears in proportion to their body size. The smallness of the ears helps prevent a large loss of body heat. Polar region animals have adaptations that help the animals conserve body heat. Examples are the emperor penguin of Antarctica, that has a thick layer of fat beneath its skin which acts as insulation, and the musk-ox, with its very thick, shaggy coat.

Animals living in mountain environments are generally surefooted because of adaptations to the structure of their feet. The Rocky Mountain goat has cuplike hooves and the Nepalese swift has sharp claws. In addition, many of these animals have heavy coats of fur or hair for insulation against cold temperatures. Internal adaptations to the respiratory systems are found in some mountain animals. The Nepalese swift, for example, has the ability to fly to heights of over 6100 m.

Water animals have structural adaptations that enable them to take the oxygen they need from the water. They also have structures that help them move through water. For example, the fins of fish help with direction and speed of movement, and the scales help the fish glide through the water.

Examples of animals that are suited to living on land and in water are frogs, alligators, beavers and otters. These animals are able to swim and yet have lungs that enable them to breathe oxygen from the air.

### Chapter 3: How do animals protect themselves?, pages 69-78

The most successful organisms in an environment are those that are best suited to compete for available food and are also able to protect and defend their food supply and themselves. This chapter considers *structural and behavioural adaptations* that animals use in order to protect themselves. The *protective mechanisms* are varied and diverse.

The mechanisms that enable mammals to protect themselves from attack exist in several forms. The most obvious are teeth, claws, armour and quills. Concealment, warning colours, foul-smelling glandular secretions, and behavioural ways (such as the opossum "playing dead") are also used to protect and defend animals against their enemies. Jackrabbits and shrews may resort to bluff tactics when they become cornered and cannot escape. In this case, the animal may try to appear larger and fiercer than it really is in order to avoid attack.

Protective colouration is the biological counterpart of military camouflage. Animals that use protective colouration for defence inherit certain patterns of pigmentation that allow the animals to blend in with their environment. The peppered moth, for example, often rests on lichen-covered tree trunks during the day because the lichen background provides the moth with an almost perfect camouflage.

The ocean-dwelling electric eel has developed specialized organs that enable it to give off electric discharges of several hundred volts, as a form of protection. Bottom-feeding rays, such as the stingray, have tails that are modified to inject poison into their enemies.

Mimicry is another form of camouflage. An animal may mimic its surroundings or it may mimic the movements and looks of another animal. The poisonous coral snake has bright yellow, black and red rings. The scarlet kingsnake, which is not poisonous, has the same colourings as the coral snake. This mimicry helps protect it from its enemies. Another example of mimicry is the one displayed by the viceroy butterfly. It has very similar colourations to the monarch butterfly. Birds eat the viceroy butterfly, but they do not like the taste of the monarch. The viceroy is often avoided, and escapes being eaten because it looks like the monarch butterfly.

Grasshoppers, crickets, and fleas rely upon jumping to escape from their enemies. Another insect, the lacewing, gives off a foul-smelling secretion when handled. Ants secrete formic acid, which may cause blistering of the skin.

### Chapter 4: What can people do to protect animals?, pages 79-91

Living things are continually *changing and interacting*, and are related to each other and to their environment. Natural or man-made changes to one part of an environmental system, will require that the other interacting parts of that system adapt or change. These concepts characterize the living environment.

Many changes to the environment have been made by people. Until recently people considered the earth and its resources as being limitless. We now recognize that except for the energy from the sun, our earth is a *closed system*, where indefinite exploitation and exploration of the earth's natural resources could have a disastrous effect on all life, including human life.

This chapter begins by considering factors and changes that have affected the balance in some environmental systems, and discusses how these changes have endangered some living things. Some of the factors that are considered are:

1. As people continue to develop more land and exploit more resources, the available space and availability of food for living things is reduced.
2. Overhunting and overexploiting certain living things have endangered some animals or caused them to become extinct. Animals have been overhunted by people for food, for furs or skins, or because the animal was considered to be a pest.

   The passenger pigeons are a dramatic example of an overhunted species which was very common until the end of the 1800's, but was extinct by 1914. The North American buffalo also nearly became extinct, and only survive today because of the passage of certain laws guaranteeing their safety.
3. Pollution of the land, water and air is also having adverse effects on many environmental systems.

The chapter then considers some conservation techniques, such as providing land for animals, controlling hunting and stopping pollution. Wildlife protection is needed to preserve as many forms of life as possible. Because each living thing is part of an interrelated life chain in an environmental system, wildlife protection is essential. Killing coyotes, for instance, would probably result in a large increase in the rodent population.

The chapter ends by considering what individuals can do to protect living things. Developing in students attitudes that are realistic and optimistic towards the use and conservation of the natural environment should be a very important aim of a school's science program. However, these attitudes are not sufficient by themselves. In addition, students must display appropriate behaviours and responsibilities toward the environment.

## TEACHING STRATEGIES

The purpose of the following activities and teaching strategies is to provide you, the teacher, with a wide variety of suggestions that can be used, together with the textbook, to help develop the processes and concepts of this unit.

### Introducing the unit, page 49

— You may wish to have your students read and discuss the cartoon and questions on page 49.

## Chapter 1: Where have all the dinosaurs gone?, pages 50-59

### Inferences ..... evidence ..... conclusions

— You may wish to begin this section by asking students to write four statements to show what they know about dinosaurs and to write four questions that they may have about dinosaurs. Share the student statements with the class.

— There will probably be a wide range of concepts about dinosaurs in the students' statements. Point out to the students that their statements are *inferences* — conclusions based on previous observations or experiences of the object, topic or event. Discuss with them the reasons for the wide range of *conclusions* (previous knowledge, sources of information, personal interest in the topic, etc...). Also stress the importance of searching for reliable evidence of facts, not jumping to conclusions, and the importance of continually revising conclusions and concepts as new information and knowledge is obtained.

— The questions that the students generated may be used in a number of ways. They may be used as a basis for a library skills research project. They may be used for some *grouping* or *classification exercises*, such as grouping the questions according to topic, or according to the *type of question — closed, open* or *evaluative.*

a. *Closed questions* call for answers that are a reproduction of facts or that require a "best" or a "right" answer — e.g. How big was the biggest dinosaur?
b. *Open questions* allow for more than one acceptable response and ask for prediction and originality — e.g. What things may have caused dinosaurs to die out?
c. *Evaluative questions* ask respondents to judge, justify or defend a point — e.g. Did dinosaurs really exist?

### Piecing the story together

— Discuss the concept of *pre-history* with your students — the period of time before records were kept. Explain that much of our knowledge of dinosaurs is based on *inferences* made from evidence and clues left in rocks.

— Have students do Activity Card 1. Ask them to *infer* what this animal might have looked like by drawing it or by making a model of it out of plasticene.

— Have students discuss the *likenesses and differences* in their models. Point out that *inferences* drawn by scientists from the evidence and clues left in rocks will not always be the same.

— For your information, the fossil skeleton is of the dinosaur Plateosaurus. It was a lizard-hipped dinosaur, about 6 m long, and a herbivore.

### Research

— The topic of dinosaurs lends itself well to a *research project.* Have your school librarian assemble all available books, films, and filmstrips on dinosaurs.

— Discuss with your students the steps involved in a research project:
identifying the research project
locating sources of data and information
selecting, interpreting and evaluating data
organizing material
recording and communicating ideas

— You may wish to have your students record a summary of their findings in the outline shape of the dinosaur that they are researching. These shapes could be mounted on a class mural. A dinosaur environment could be created around them.

### Prediction

— You may wish to have your students *predict* into the future. *Using data* that they are able to *collect* about their community as it exists today, ask them to predict changes that will likely occur in the next 100 years.

### Dinosaur Mathematics

— As students are researching their dinosaurs, have them write down on cards any data that they may find on the *size, mass, height* or *length* of dinosaurs. Ask them to print the name of the dinosaur on top of the data card.

— You may wish to have your students use this data to do Dinosaur Math — Activity Cards 2.1-2.6

### Movement Education

— Groups of students could be asked to *arrange* themselves in *dinosaur shapes.*

— They could then be asked to make the *"dinosaur" move.*

— Students could also be asked to dramatize through movement, the meeting of a *plant-eating and a meat-eating dinosaur.*

### "Finding Out" (page 57)
### How are some fossils made?

— You may wish to have your students complete Activity 8 in their Activity Books (Textbook page 57)

*Processes used and findings:*

— *Observation Skills.* By *observing* the "fossil" imprints in the mud, students should list and describe the properties of each imprint. Try and develop in students the ability to list both *quantitative* (measurable) and *qualitative* properties. Some questions that could help the students with their observations are: What shape does it have? How long ... deep ... wide is it? What does the imprint look like? Does it have any special features? A class chart could be devel-

oped to compare the data collected by the students, on the various "fossil" imprints.

— *Inference Skills.* Based on the observed properties of the "fossil" imprints, students can be asked to make *inferences* about the size, shape and mass of the objects that left the imprints.

— *Communication Skills.* You may wish the students to *communicate* their observations, in oral or written form, by *identifying* and *comparing* the "fossil" imprints. Students could also be asked to describe how a "fossil" imprint is made.

### Extension activities (page 57)

— You may wish to consider the following extension activities after students have completed the "Finding Out" on page 57.

— 1. Footprints. Find some wet soil on the schoolground. Have students walk forwards and backwards. Have them walk, run and hop. Have the students *observe* the shoeprints. Ask them to make *inferences* and *comparisons* about the mass of the students making the footprint. They could also *infer* the direction of movement and the type of movement from the print.

— 2. Cast and Mold Fossils. Have students research the differences between a cast and mold fossil. Then ask students to design an activity to make a cast and a mold fossil.

Note: A mold fossil is formed when the living thing is covered by soft sediment. The sediment hardens, and in the process, the plant or animal decays and dissolves, leaving a hollow print or mold. If minerals or sediments fill this mold, they may harden in the shape of the mold. This forms a cast fossil.

— 3. Fossil Collection. Carry out the "Finding Out" using actual fossils from a school fossil collection or using fossils that students bring to school.

### Chapter 2: How are animals suited to where they live?, pages 58-68

### Group Research

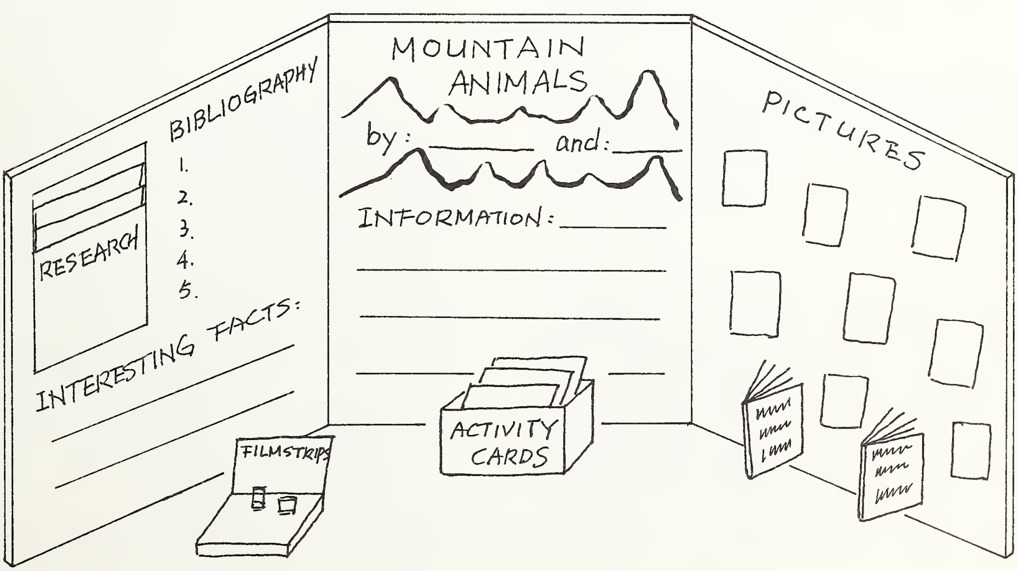
— You may wish to divide students into groups, and assign each group a particular animal environment as a research project. Each group would be responsible for researching their topic; for locating and selecting books, films and filmstrips on the topic; and for preparing a study centre on the topic that could be used by other students in the room or the school. The study centre could include an information panel, filmstrips, books, pictures, activity cards and games for students to use.

— You may wish to *evaluate* this research project according to how well the topic was researched, the content, presentation and interest level of the study centre and how well group members shared responsibilities for the project.

### Picture Analysis

— There are a number of photographs in this chapter, showing a variety of animal environments. You may wish to ask your students to study the photographs closely, and from their observations, make the following inferences:

- — What are the environmental factors (humidity, temperature, vegetation, elevation, etc...) of the environment shown in the photograph?
- — What characteristics (adaptations) are shown in the pictures that make the animal suited to its environment?



— Students could be asked to record their findings on a three-column chart. The first column could list the animals, the second column could be used to describe the environmental factors and the third column could indicate the adaptations inferred from the pictures.

### Map Study

— A large world map could be outlined on chart paper. Students could be asked to *collect* pictures of animals and to *infer* from the characteristics displayed in the pictures the environment to which the animal is suited.

— They could describe their *inferences* to the class. After discussion, the animals could be pasted on the world map, in the environment that was decided upon by the class.

— Students could be *assessed* on how well they are able to describe specific animal adaptations, on whether they are able to locate countries and environmental factors on the world map, and on how they contribute to the class discussion.

### Adapt-an-Animal

— After studying this chapter, you may wish to ask your students *to invent* an animal that could survive on the schoolgrounds. Before they make their animal, they should consider and *collect data* on the environmental factors (climate, availability and type of food, dangers and natural enemies, etc...). They should then invent *structures and behaviours* that would enable the animal to *adapt* to the schoolground environment.

— Students could then design their animal and make a model of it or draw it. They could also invent a name for it.

— Assessment could be on originality, on how well data on the schoolground environment was collected and on the level of understanding that the student displays on the concept of adaptation.

### Impossible ...... But Maybe!!

— To reinforce the concept of *"adaptation"*, you may wish to have students cut out animal pictures and paste them onto pictures displaying unsuitable environments for those animals, e.g... a polar bear picture pasted onto a desert environment.

— The pictures could be exchanged between students. In groups, they could discuss why these animals are not suited to that particular environment.

— They could then be asked to redesign the animal to make it suit that environment.

— A classroom display could be made of these animal designs.

### "Finding Out" (page 68)

### How is a frog or salamander suited to living in water and on land?

— You may wish to have your students complete Activity 9 in their Activity Books (Textbook page 68).

*Processes used and sample findings:*

— *Observation Skills.* Students could *observe* the animals, according to how they carry out their life functions. The observations could be recorded on a chart. The students should *collect data* for the chart on a number of different occasions. This is an important procedure to develop in students—*observing an object* or *event a number of times* before making use of the data collected.

— *Inference Skills.* Once the students have *observed* and *identified* the adaptations of the animals, they can be asked to make *inferences* on how these adaptations help the animal live in water and on land. These inferences could be added to the chart.

### Communication Skills

— You may wish to have students *communicate* their observations and inferences on a chart and *compare* their charts with other students' charts. A sample chart is shown on the following page:

### Extension activities, (page 68)

— You may wish to consider the following extension activities after students have completed the "Finding Out" on page 68.

— 1. The School Aquarium. If your school has an aquarium, you may wish to have students find how fish are suited to their environment. Ask your students to *observe* how a fish moves through the water: what parts of the body move the fish; do all the fins and tail move at once; does the body twist and turn during movement; how does the fish swim up or down, or turn. They may also observe how fish eat and how they breathe. They could also be asked to draw a map of the aquarium to show the position of different fish. They could then try to determine if fish that seem to stay at any particular level have special adaptations. *Inferences* may then be made about how these adaptations enable fish to live in a water environment.

— 2. Schoolground Observation. You may wish to have your students *collect data* on animals living in environments that are located on your schoolgrounds. Examples of environments that may be found on a schoolground are: grassy areas, under trees, under rocks, in rotting logs or wood and in the soil. They could then make *inferences* on how these animals are suited to their environment.

— 3. Field trip to a zoo or farm. There would be many opportunities on a field trip for students to extend the concepts and processes of this chapter.

| *What I Observed My Frog/Salamander Doing* | *How My Animal Did it (Adaptation)* | *How Does This Help My Animal Live On Land and In Water? (Inferences)* |
|---|---|---|
| *Swimming in water* | *Webbed Feet* | *The webbed feet help the animal move through the water.* |
| *Walking/jumping on land.* | *The frog has long hind legs that it kicks back when it jumps.*<br><br>*The salamander walks like a lizard. It covered a distance of ____ cm in ____ sec.* | *Helps the frog get away from its enemies. It helps the frog catch insects.*<br><br>*The salamander can go on land to look for food or to hide under leaves or rocks.* |
| *Responding to a noise* | | |
| *Feeding* | | |
| *Breathing* | | |
| *Seeing, etc...* | | |

## Chapter 3: How do animals protect themselves?, pages 69-78

### Protection Graph

— As students read and discuss the different protective mechanisms of animals that are described in this chapter, you may wish to have them do Worksheet 1.
— Have them *classify* animals according to the protective mechanism they use. Then place the names on the graph.

### Research

— You may wish to combine the concepts of chapter 2 and chapter 3 in a research project. Place some cards that have the picture and name of an animal in a "Research Box". Students could then be asked to select five different animals from the cards. They could prepare a three-column chart. In the first column, they would list the five animals. In the second column, they would list how these animals are adapted to their environment. In the third column, they would list the way each animal protects itself from its natural enemies.
— Some animals you may wish to consider are:

| | | |
|---|---|---|
| wasp | weasel | skunk |
| deer | toad | ptarmigan |
| rabbit | porcupine | ant |
| scorpion | woodchuck | robin |
| gerbil | pheasant | praying mantis |
| octopus | camel | seal |

### Movement Education

— From photographs of animals or from a film, if one is available, ask students to develop a word list that would describe animal movement. Words such as slither, jump, slide, crawl, gallop, hop and glide could be developed. The animal movements could be called out and students could try to act out the movement. For example: "slither like a snake", or "jump like a frog".

### What If?......

— You may wish to expose students to some hypothetical situations, where they would have to display some protective behaviours.
— Some situations are given in Activity Cards 3.1 to 3.6
— These cards might best be done through class or group discussion.

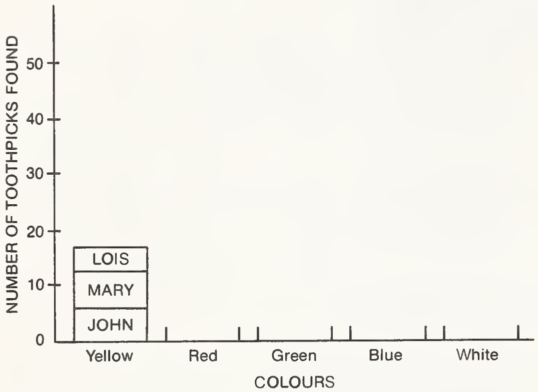
### "Finding Out" (page 71)
### Is it hard to see something when it is the same colour as the things around it?

— You may wish to have your students complete Activity 10 in their Activity Books (Textbook page 71)
*Processes used and sample findings:*
— *Prediction Skills.* Before the students try to find the different coloured toothpicks, have the person who placed the toothpicks in the grass indicate how many toothpicks of each colour they used. Ask the students to *predict* how many toothpicks of each

colour they will find in the two minute period. Their predictions can be recorded on Worksheet 2.

— *Observation Skills.* Students will be *observing quantitative* properties (number of each colour found) and *qualitative* properties (the colours of the toothpicks). The students will probably observe that the green toothpicks were the hardest to find.

— *Using Numbers.* Students will be counting the different coloured toothpicks. You may have all the collected data placed on a class graph, so that students are able to use more substantive data in the *comparisons* and *inferences* that they make.




— *Comparison Skills.* Students will be *comparing* their field data with the *predictions* they made. They also will be comparing the concealment properties of the different coloured toothpicks.

— *Inference Skills.* The students may *infer* that the green toothpicks were the hardest to find because their colour was about the same as the colour of the grass. They may infer from this that some animals are hard to find in their natural environment because the colour of the animals is about the same as the colour of the things around the animals.

### Extension activities, page 71.

— You may wish to consider the following extension activities after students have completed the "Finding Out" on page 71.

— 1. Insect Camouflage. The bark of trees is very often used by insects for camouflage. Have your students make bark rubbings of three different trees on the schoolgrounds or in the neighbourhood. Bark rubbings are made by placing the sheet of paper against the bark and gently rubbing over the paper with some charcoal or a soft pencil. Ask the students to *predict* the characteristics of insects that would use the bark for camouflage. Have them draw the insects on the bark rubbings. Students could then return to the trees and *observe* the bark carefully for insects. If any are found, they could *compare* the insects to the drawings they made. If they are unable to find insects on the tree, they could try to find pictures of similar insects in a field guide for insects.

— 2. An Imaginary Animal: Ask students to select a particular environment on the schoolgrounds. Using a variety of materials (egg cartons, potatoes, popsicle sticks, cotton, glue, plasticene, paints) ask the students to make an animal that will blend into the environment they selected. On completion, the students could place the "animal" on the site. Students could then search for the animals. A time limit should be placed on the search. Students could then *infer* why some of the animals were easy to find and why some "animals" were difficult to find.

### Chapter 4: What can people do to protect animals?, pages 79-91

### Comprehension Skills

— You may wish to use this chapter to help students develop *comprehension skills* as they read in a content area. The chapter is divided into the following sections:
  - — Why are some animals dying out?
  - — What is being done to help save animals?
  - — What can you do to protect animals?

For each section, ask students to:

— 1. Identify the main idea. Ask them the following questions:
  - — What is the most important sentence in the section?
  - — Can you summarize the section with one word?

— 2. Recognize significant details. Point out to students that in any form of writing, some facts are more important than others.

— 3. Note the sequence of events. The sequence of written materials often enables the reader to see relationships and draw conclusions. Ask students to place the significant details in the order that they occurred.

— 4. Draw Conclusions. To draw conclusions, the student must see the *relationships among the facts.* Students should be given practice in drawing conclusions, both by considering all facts when they are available and by making *inferences* when only some facts are available. From the information that they have in each section, students could be asked to draw conclusions, make inferences or predict outcomes.

— 5. Think Critically. Students should be given the opportunity to try to separate fact from opinion and to recognize bias in written material. They could consider the following questions:
  - — Which statements are fact and which are opinion?
  - — Do you think this information is true in this community?
  - — How did the writers try to influence you?

### Endangered Species

— You may wish to consider a number of activities when studying endangered species.

— 1. On the world map students could place a *symbol* representing the endangered animal at the appropriate location. *Comparisons* could then be made between successful and endangered animals. Students could try to *hypothesize* reasons for successful or unsuccessful adaptations.

— 2. Students could use films, filmstrips, books, resource people or field trips to *research* an endangered animal. They could present the research project as a talk to the class or in booklet format.

— 3. Students could carry out a similar research project for the animals that have now become extinct.

### Field Trips

— Field trips to zoos, animal sanctuaries, farms, ecology centres or provincial parks could be used to further develop the concepts of this chapter.

— If there are resource people at these field trip sites, you may wish to have the students plan some interview questions that they could use to find out about animal protection and conservation.

— After the field trip, they could write thank you letters to the resource people, and in the letters, they could indicate their impressions and feelings about what they observed.

### Poster Design

— After studying this chapter, students could be asked to *design* a poster on conservation or animal protection to be put on display around the school.

— The components of a good poster—the design, use of colours, developing a slogan that is catchy and gives the message—could be discussed.

### Community Studies

— You may wish to use the school's neighbourhood to *investigate* some of the following topics:

— What changes are taking place in your neighbourhood? What effect are these changes having on the total environment? Classify them as good or bad changes.

— Is there evidence of pollution on the schoolgrounds or neighbourhood? If there is, what can be done to change the situation? Keep a record of the improvements that occur.

— Are there some animals that have adapted themselves to your neighbourhood and now live in it? Examples of animals that have adapted to some neighbourhoods are the housefly, the cockroach, the mouse, the raccoon, the sparrow and the pigeon. List the animals in your neighbourhood, and through observations or research, give reasons why they are able to survive in your neighbourhood.

### "Finding Out" (page 81)
### What does overcrowding do to mealworms?

— You may wish to have your students use Worksheet 3 when completing Activity 11 (Textbook page 81).

*Processes used and sample findings:*

— *Observation Skills.* As students are being asked to see if the mealworms are getting "bigger", it is necessary that they *quantify* their observations. You could ask students what is meant by the word "bigger". Their answers might include the properties of *length, width* and *mass*. They might decide that measuring only one of these properties—length, for example—will demonstrate that growth is occurring.

— *Measurement Skills.* You may wish to ask your students some ways in which they could *measure* growth of the mealworms. They will probably conclude that they would need to *average* the measurements that they take. For example, if they were measuring length:

$$\text{Average length of mealworms} = \frac{\text{Sum of the lengths}}{\text{Number of mealworms}}$$

Another measurement task that should be discussed with the students is the problem of giving each mealworm population the same amount of food. How are they going to measure out the same amount of bran and lettuce?

— *Variables.* You may wish to discuss with your students the things *(variables)* that may affect the growth of the mealworms. Their answers might include, the amount and frequency of food, the type of food, the amount of heat and light, the size of the container, etc... Discuss with your students the importance of *controlling* these variables for this investigation and determine ways of controlling the variables.

— *Comparison Skills.* Students will be *comparing* the data from the two mealworm populations in order to make their *inferences.*

— *Inference Skills.* After observing the mealworms for about a week, the data should indicate that the 18 mealworms in the one jar have not grown as much as the 6 mealworms in the other jar. The students may *infer* from this that overcrowding does affect mealworms because they do not have enough food to grow.

— *Communication Skills.* You may wish to have your students write summaries of procedures and conclusions, and to use a chart to display the data that they collect.

### Extension activities (page 81)

— You may wish to consider the following extension activities after your students have completed the "Finding Out" on page 81:

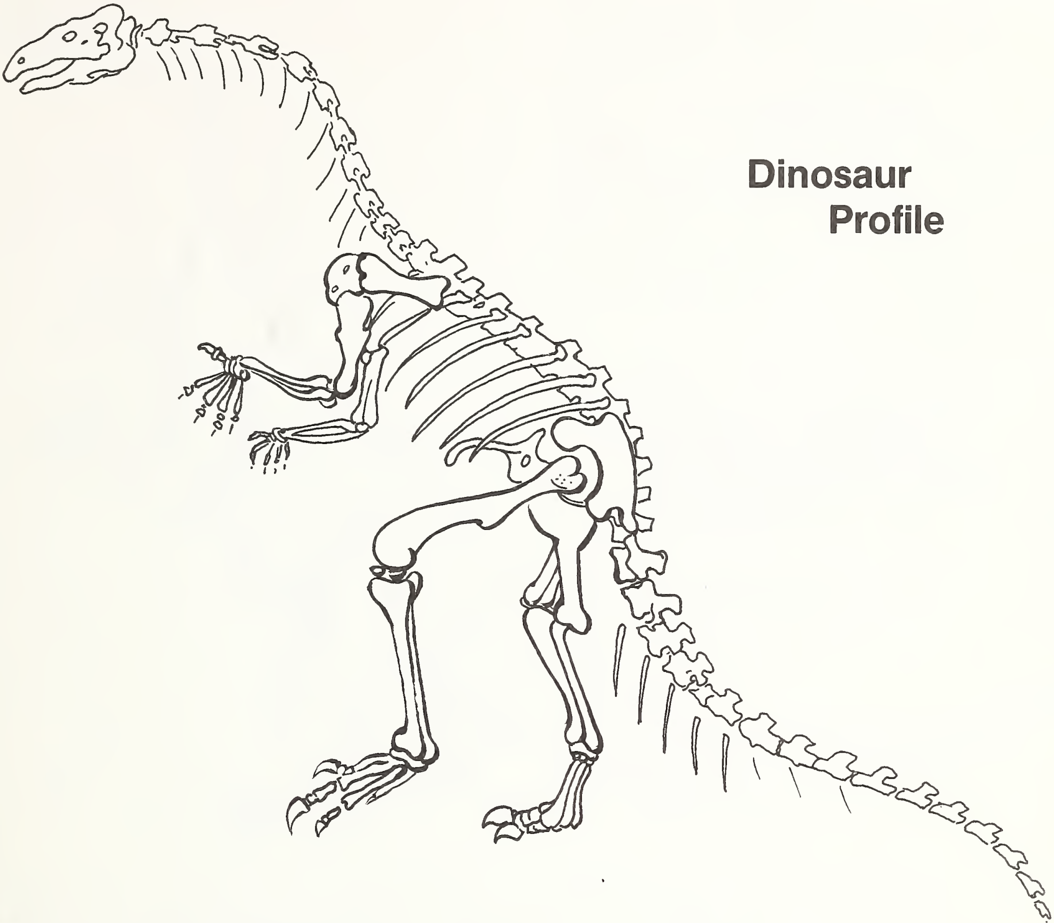
— 1. A Mealworm's Environment. You may wish to further involve students with investigations, using mealworms that were used in the "Finding Out".

Students could be asked to find out the environmental factors that best suit a mealworm population. Students could try and *control variables* such as the amount of light, amount of food, amount of heat, or amount of moisture (lettuce leaves) with mealworms in different containers. They could *observe* the populations on a regular basis, and *record, measure* and *compare* growth in the mealworm populations. From their data they could *infer* the environment conditions that best suit the mealworm. This activity would be a good review of many of the concepts presented in this unit.

— 2. Life Cycle of the Mealworm. During the previous activity, the mealworms, which are the larval stage of an insect, will probably go through the pupal, adult and egg life stages. You may wish to have the students *observe* the life cycle of the mealworm.

— 3. Fruit Flies. Investigating overpopulation with a fruit fly culture is an interesting and dramatic way of extending this "Finding Out". Fruit fly (Drosophila) cultures and the necessary nutrients should be available from a science supply house or a local high school biology department. You may wish to have students start their own fruit fly population. This can be done by placing a piece of overripe banana on a paper towel in a bottle. Fruit flies should be attracted to the banana. *Be sure to put a lid on the bottle!* The lid should be pierced with some small holes.

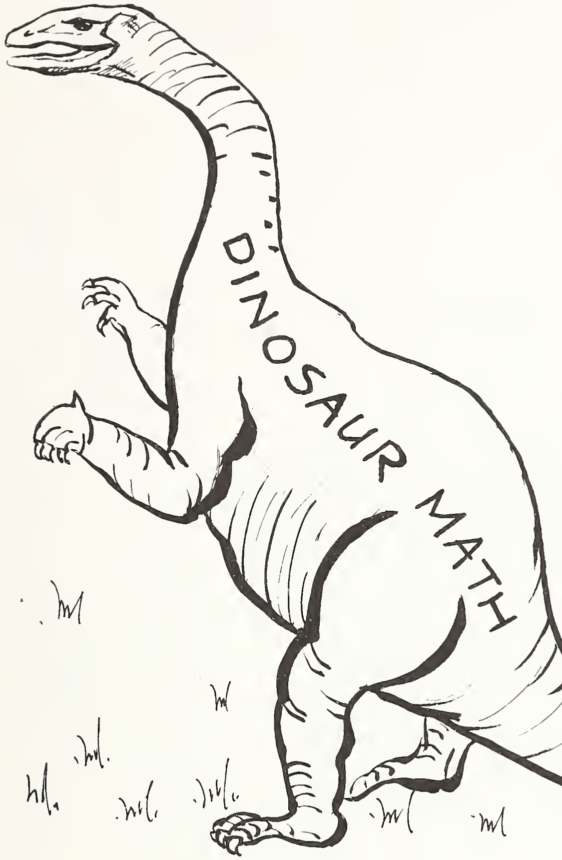
— 4. Grasshoppers. Grasshoppers, if they are available, are another animal that can be used to demonstrate overpopulation in a fascinating and very dramatic way.



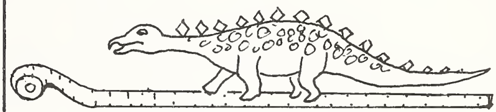
## Dinosaur Profile

- What might this dinosaur have looked like?

- Draw it, or make a model of it out of clay.
- Compare your drawing or model to those of your classmates.




List dinosaurs in order from the shortest to the longest dinosaur.

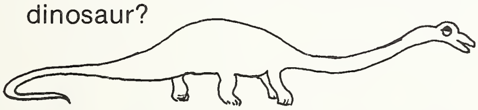


2.1

Measure the length and width of your classroom. How many _______ dinosaurs would fit in your classroom?

2.2

What is the difference in length between the shortest and longest dinosaur?



2.3

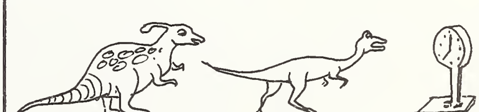
Go outside and mark out the length and height of the largest dinosaur.
Compare this to the length and height of your school.

2.4

Weigh yourself.
How many of your weight would it take to balance a 27 000 kg Brontosaurus on a teeter-totter?

2.5

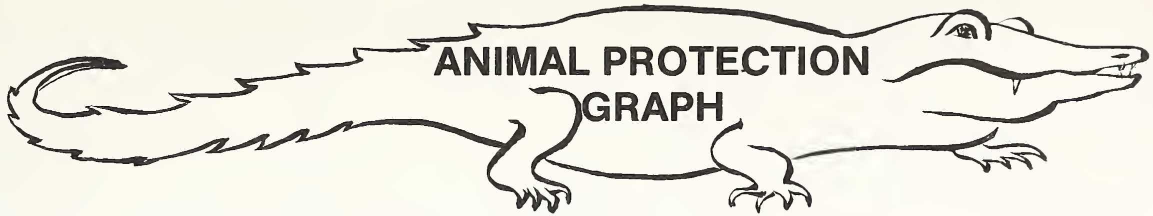
List dinosaurs in order of mass.



2.6

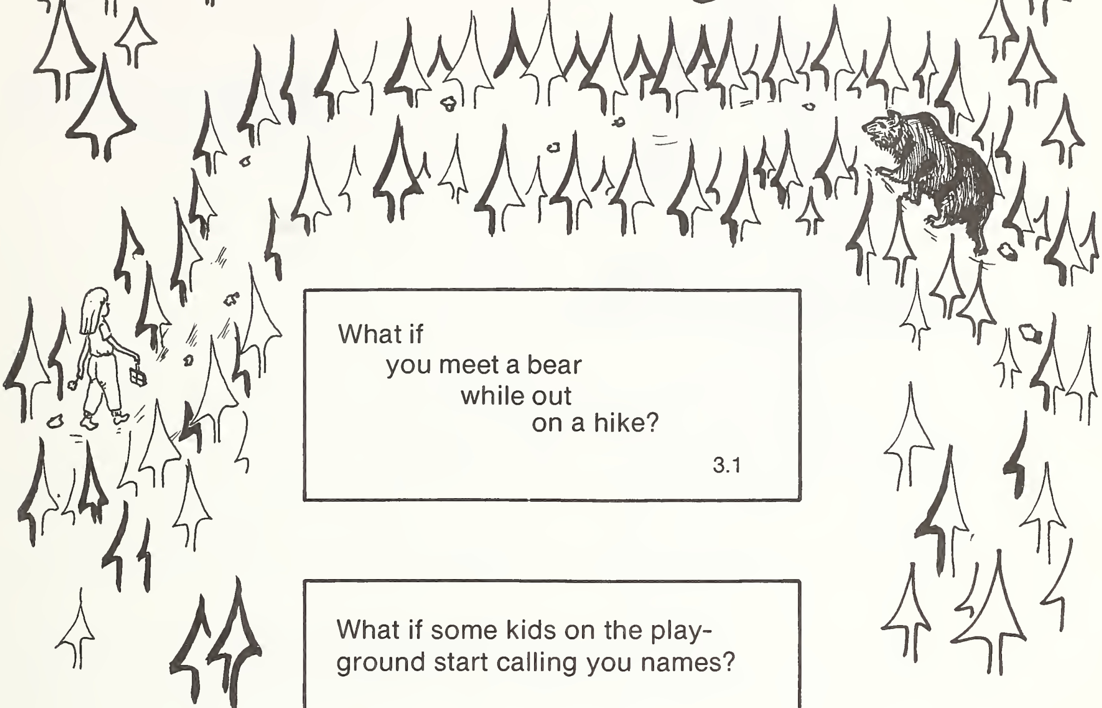
Animals and Their Environment, Activity Cards 2-1 to 2-6

# ANIMAL PROTECTION GRAPH



| METHOD OF PROTECTION | ANIMALS | | | | | | |
|---|---|---|---|---|---|---|---|
| CAMOUFLAGE | | | | | | | |
| JUMPING AND RUNNING | | | | | | | |
| USING CHEMICALS | | | | | | | |
| TEETH OR TUSKS | | | | | | | |
| HOOVES OR CLAWS | | | | | | | |
| ARMOUR | | | | | | | |
| MIMICRY | | | | | | | |
| OTHER... | | | | | | | |
| OTHER... | | | | | | | |

# What If...



What if
you meet a bear
while out
on a hike?

3.1

What if some kids on the playground start calling you names?

3.2

What if you see someone littering the playground environment?

3.3

What if some oil catches fire on the stove while you are in the kitchen?

3.4

What if you are stranded in a snow storm without any protective clothing?

3.5

What if your best friend starts ignoring you and spends a lot of time playing with someone else?

3.6

Animals and Their Environment, Activity Cards 3-1 to 3-6

**"Finding Out" (Page 71)**

**Is it hard to find something when it is the same colour as the things around it?**

# I Predict...

that I will find this many toothpicks of each colour during the two minute period:

| | YELLOW | RED | GREEN | BLUE | WHITE |
|---|---|---|---|---|---|
| My prediction: | | | | | |
| The number I found: | | | | | |

Animals and Their Environment, Worksheet 2

**"Finding Out" (Page 81)**

**What does overcrowding do to mealworms?**


# Population Study

| | AVERAGE LENGTH OF MEALWORMS | | | | AVERAGE GROWTH D–A |
|---|---|---|---|---|---|
| | DAY 1 A | DAY 3 B | DAY 5 C | DAY 7 D | |
| 6 MEALWORM POPULATION | | | | | |
| 18 MEALWORM POPULATION | | | | | |

Animals and Their Environment. Worksheet 3

# BROWN BOOK (4)
# Unit 3: Work and Machines
**Pages 96-143**

### UNIT OVERVIEW

#### Concept Development

In the preceding levels of the program, the following concepts were introduced and developed:

Objects will not move unless something starts them moving, and will keep moving until something stops them. Forces exerted on objects cause them to move. Forces can come from muscles, machines, gravity or magnets.

In this unit, the concept of work is developed. Children are familiar with the everyday use of the word "work". Yet most children do not have an understanding of the scientific or operational meaning of work—*that work is done when a force causes an object to move or to change the way it is moving.* The amount of work done depends on the distance the object moves and the amount of force applied to the object. If work is to be done, the forces of gravity, inertia, and friction must be overcome.

The unit also considers the six kinds of simple machines that can be used to make work easier. These simple machines can be combined to make compound machines.

These concepts are developed in four chapters. Chapter one defines work. In the second chapter, simple machines are considered. Chapter three considers some compound machines and their uses. In chapter four, the concept of force is developed and gravity, inertia and friction are considered.

#### Process Development

In the "Finding Out" on page 101, students *measure* and *compare* how a variety of objects stretch an elastic band of a simple scale. They make *inferences* and *hypotheses* from their data. You may wish to develop the concept of *variables* in this "Finding Out", as the size, thickness and strength of the rubber bands used, will affect how much the rubber bands stretch.

Students then *measure* and *compare* the forces required to pull a cart up a short and a long inclined plane (page 106). You may again wish to discuss the *variables* that will affect this investigation. The efficiency of the cart, the angle, type of surface and length of the inclined plane are variables that will affect the force required to pull the cart up the inclined plane.

The efficiency of screws and nails are investigated in the "Finding Out" on page 111. From the *observations* and *data* that they collect by joining and then trying to separate pieces of wood, students make *inferences* and *comparisons* about the holding ability of nails and screws.

On page 115, students change the position of a fulcrum in a lever and *measure* and *compare* the force needed to lift a load. From their *observations*, they make *inferences* about the effect of the position of the fulcrum in lifting a load. This is followed on page 119 by an investigation *comparing* the efficiency of a large and a small wheel. From their *observations* students make the *inference* that less force is needed to turn a large wheel than a small wheel.

Students construct different sized gears in the "Finding Out" on page 122. They *observe* and *compare* the speed and direction of turn of the connected gears. They then *experiment* to see how a gear could be set up to turn a wheel. On page 124, students investigate how a system of pulleys moves a load from one point to another. Students then experiment with their pulleys to move loads horizontally, at a gradient and vertically.

Students then investigate the forces of gravity, inertia and friction. In the "Finding Out" on page 134, students *observe* that when a piece of paper is pulled away quickly from under a penny, the penny does not move. They make the *inference* that as no force is applied directly to the penny, it does not move. From their investigations with moving two blocks of wood, (page 136), students make the *inference* that once something is in motion, it will continue to move until another force stops it. Students then investigate how friction affects the ability to do work, in the "Finding Out" on page 138. They consider the *variables* of the types of surfaces rubbing together and the mass of the object being moved.

In addition to developing observing, comparing, inferring, measuring, communicating, hypothesizing, interpreting data and experimenting skills, this unit also provides the opportunity to give students practical experiences that demonstrate how the science of mathematics is used. Perhaps only a few of the students might be able to calculate the numerical relationships. However, nearly all of the students should be able to understand the mathematical concepts underlying relationships connecting force, distance, inertia, gravity and friction.

### Related Units

Location, Motion, and Force *Blue Book (3)*
Changes in Energy *Red Book (6)*
Energy: For Work and Motion *Exploring Matter and Energy (7)*
Technology: Using Science *Exploring Matter and Energy (7)*

### Materials and Advance Planning

The following list includes the materials that a student, or in some cases a group of students, need to carry out the activities in this unit. In some instances other materials may be substituted for those on the list.
Ruler, rubber band, paper clip, tape, small objects such as keys or pens, about 5 books, small toy cart or toy car, spring scale (made with ruler, rubber band, and paper clip), 8 or 9 small boards, wood screw, screwdriver, nails, hammer, thin book, small flat rock or other flat object, broomstick or other long stick, cardboard, scissors, 2 thread spools, string, paper, penny, 2 small blocks of wood, 3 shoe boxes, 5 or 6 rocks, sandpaper, waxed paper.

The additional activities suggested in the Resource Guide require: 10 m of rope, a piece of plywood, an old tire, two plastic pails, a bag of sand, a spring scale, a board, heavy pulpboard, straws, 2 aluminum pie plates, 4 toy wheels of different diameter, 20 cm of balsa wood, small pieces of cloth or plastic.

## BACKGROUND INFORMATION

### Chapter 1: Work, work, and more work! pages 98-103

The concept of work is synonymous with effort in the minds of many people. Science however uses only the operational definition of words, thus work is only done when sufficient force has been exerted on an object to cause it to move some distance. A student pushing against a wall or studying time tables is not doing work in the scientific sense. Energy will be expended by the student but no "work" will be done.

The student cannot exert enough force on the wall of the building to cause it to move. However, the student could exert enough force on a garbage can to cause it to move and work would be done. Lifting, pulling or pushing are forces needed to move objects. Work is a direct relationship of force and distance, so that carrying a garbage can up four steps requires half as much work as carrying a garbage can up eight steps.

### Chapter 2: Simple Machines, pages 104-125

This chapter considers the six classes of simple machines, the inclined plane, the wedge, the screw, the lever, the wheel and axle, and the pulley.

Inclined planes are sloping surfaces that move objects from one level to a higher level. Unlike some other simple machines, which move when they are used, the inclined plane itself does not move when it is used. Some familiar inclined planes are ramps, stairways, and sloping roads.

Another simple machine that helps people do work is a wedge. A wedge can be thought of as two inclined planes fastened back to back. A wedge has several uses. For example, it can be used to push things apart (splitting a log) or a wedge can help lift things and hold them in place, (helping to lift a heavy door to the correct height before hinging it to a doorframe). In contrast to an inclined plane, which is stationary, a wedge moves into or under an object. The longer or the thinner a wedge is the less force is needed to use the wedge. But again, the longer or the thinner a wedge is, the greater the distance the wedge must be moved to complete a job. Therefore, the amount of work done when using a longer or a thinner wedge is the same as the amount done when using a shorter or a thicker wedge. Other examples of wedges are knives, needles, nails, razor blades, snowplow blades, bows of boats, teeth (front) and chisels.

Another kind of simple machine is a screw. Most people think of a screw as an object that holds together pieces of wood or metal. However, a spiral staircase, a road that winds around a steep mountain, certain lids of jars, and certain automobile jacks are also examples of screws. Turning a screw forces it into or causes it to lift an object. Some screws have spiral threads that are far apart. Such screws require more force but less turns to drive them into a piece of wood or to lift an object a certain distance. Other screws have spiral threads that are close together. Such screws require less force but more turns to drive them into a piece of wood or to lift an object a certain distance. However, the amount of work done with either kind of screw is the same.

A seesaw is a common piece of playground equipment. However, a seesaw is also an example of another kind of simple machine, namely, the lever. Levers are made up of three parts—the fulcrum, the load arm and the force arm. The fulcrum is the point on which the lever rests. The load arm is the point on which the load rests. The force arm is the point at which a force must be exerted to move the load.

On a seesaw the fulcrum is in the middle, the load arm is on one end, and the force arm is on the other end. The load and the force arms alternate as the seesaw is moved up and down. Other common examples of levers in which the fulcrum is located somewhere between the load arm and the force arm are crowbars and tackpullers. Other levers have the load somewhere between where the force is applied and the location of the fulcrum. An example of this kind of lever is a wheelbarrow. Still another kind of lever has the force applied somewhere between the fulcrum and the load. This kind of lever includes a fly swatter, a broom and a ball bat.

Another simple machine is the wheel and axle. An axle is a rod to which a wheel is attached. If either the wheel or the axle turns, the other part also turns. The

wheel part of the wheel and axle machine does not have to look like a wheel, as long as it turns like one. The handlebars of a bicycle, for example, do not look like a wheel, yet they function as a wheel. A doorknob, a screwdriver and the pedals of a tricycle are further examples of a wheel and axle machine.

When teeth are put on the wheel of a wheel and axle machine, the wheel is called a gear. There are gears within watches that turn the hour, the minute and the second hands. The gear that turns the hour hand is large, and the teeth are spaced fairly far apart. The size of the gear and the spacing of the teeth cause the hour hand to move the slowest of all the hands. The gear that turns the second hand is the smallest, and the teeth are very close together. Thus the gear controlling the second hand moves the fastest of the three gears. There are also gears in a bicycle. A large gear is turned by the pedals and is attached by a chain to a smaller gear in the back wheel. Because the smaller gear turns faster than the larger gear a speed greater than the pedaling speed can easily be attained.

A pulley is also a simple machine. It is made up of a rimmed wheel that turns around a fixed axle. Usually the wheel is turned by pulling an attached rope. There are two kinds of pulleys, fixed and moveable. A fixed pulley is stationary. It is used solely to change the direction of a force, such as when raising or lowering a flag on a flagpole. Fixed pulleys are also found in venetian blinds and traverse rods. A moveable pulley moves up or down the rope, which requires less force than that needed for a fixed pulley. Often, a fixed and a moveable pulley are connected, forming what is called a block and tackle. In a block and tackle, the upper pulley is fixed and the bottom one is moveable. A block and tackle is almost always used to lift extremely heavy objects because less force is required to move such objects. Some examples of equipment having block and tackles are cranes and power shovels.

### Chapter 3: Teams of machines, pages 126-131

All machines are made up of simple machines. However, when two or more simple machines are used to make another machine, that machine is called a compound machine.

People use a great many compound machines every day. A pair of scissors, for example, is a compound machine that is made up of two levers and two wedges. There are many kinds of scissors. There are those that have short handles and long blades. Such scissors are used for easy-to-cut materials—such as paper, thin cloth or hair. There are also scissors that have long handles and short blades. They are used to cut heavier materials. Tin snips and bolt cutters are examples.

There are many other examples of compound machines. Some examples are a bicycle, a rod and reel, an eggbeater, a hedge clipper, a rake, a hoe and a meat grinder.

### Chapter 4: Why work at all? pages 132-139

To do work, with or without machines, people must continually overcome three natural forces. They are gravity, inertia and friction.

Gravity is the attraction one object has toward another. And the greater the mass an object has, the more attraction that object has for other objects. Since the earth has so much more mass than any object on it, all objects on the earth are attracted to the earth. Although people can overcome the force of gravity in some instances, by using only muscular power, people have found that they can overcome the force of gravity more easily by using machines. Among the machines that people use to overcome the force of gravity are inclined planes, pulleys, elevators, escalators, cranes, airplanes and vehicles that go uphill.

Besides gravity, another force people must overcome in order to do work is inertia. Inertia is the tendency a stationary object has to resist being moved and the tendency a moving object has to resist being stopped. People can feel the force of inertia while riding in an automobile. If the automobile starts off rapidly, people feel their body being momentarily pressed backward. And if the automobile stops suddenly, people feel their body being momentarily pushed forward. Feeling the force of inertia is also experienced when getting on and off an escalator.

Besides gravity and inertia, people also must overcome the force of friction in order to do work. Friction is the rubbing of one surface against another. Thus, the force needed to push a box across a floor, for example, must be greater than the force of friction resulting from the rubbing together of the two surfaces.

People have discovered, however, that there are ways to reduce friction and therefore reduce the force needed to move objects. For example, if a box were placed in a wagon, the box could be moved more easily than if the box were pushed or pulled across the floor. This is because the rubbing of the box against the floor would be eliminated. However, some continued push or pull would still be needed, since there would be friction between the wheels of the wagon and the floor.

Although friction is often a problem, more problems would exist if there were no friction. For example, without friction, people would not be able to walk, to write or to brake a car.

## TEACHING STRATEGIES

The purpose of the following activities and teaching strategies is to provide you, the teacher, with a wide variety of suggestions that can be used, together with the material presented in the textbook, to help develop the processes and concepts of this unit.

### Introduction, page 97

—Following a discussion of the cartoon on page 97,

consider some easier ways of doing some simple tasks-e.g. to pick up a large number of straight pins spilled on the table or floor (use a magnet).
— Have the students compile a list of simple tasks that they are sometimes given—e.g. taking out the garbage or mowing the lawn.
— Have student select one of these tasks and then 'plan' an easier way of completing this task. You may wish to have your students record their 'easier way' using Worksheet 1.

### Chapter 1: Work, work, and more work, pages 98-103

— To introduce this chapter provide pantomimes of a number of work tasks. Have the students determine what work is being demonstrated.
— List main concepts of the chapter for the students. Discuss 'workers' in pictures on pages 98 and 99. Who is working?
— Have the students pantomime work tasks.
— Permit students to rearrange all the furniture in the room for the day. When everyone is settled in their new location, a discussion of work involved can follow. This discussion will reinforce the concept that the amount of work you do depends on the distance you move something.
— Worksheet 2 should help the students understand that no matter how much force is applied to an object, if it does not move no work is done.

#### For You to Think About

> Suppose you had to carry your bicycle along a hallway while your friend had to carry his bicycle the same distance but up a flight of stairs. Who would do more work? Why?

— Divide the class into two teams for a tug-of-war. Organize the teams so that each team has the same total mass. Discuss how much work is done.

#### "Finding Out" (page 101)

#### How can you compare the pulling force of objects?

— You may wish to have your students complete Activity 12 in their Activity Books (Textbook page 101).

*Sample answers*

1. The object named will vary, but it will pull on the rubber band with the most force because it is the heaviest object.
2. No. Objects that are large are not always heavy.
3. When comparing objects that are of light weight.
4. When comparing objects that are of heavy weight.

#### Machines help make work easier (page 103)

— In order that the students may observe how machines make work easier, plan a field trip to see machines at work. You might visit:
(a) a site where a grader or a bulldozer is working
(b) a machine shop
(c) a newspaper plant
(d) a manufacturing plant
— Have each student prepare a description that includes a picture, some basic facts (size, weight, noise, operators, etc.) and information about the product of a machine observed.
— A booklet could be prepared of these descriptions.
— Activity Cards 1-1 to 1-16 will help students realize there are many machines about them.
— Students complete the name of the machine shown and tell how this machine makes work easier.
— Have students provide pictures or photographs of machines that make work easier. A display could be made of the pictures.

### Chapter 2: Simple machines, pages 104-125

#### Research teams

— Use a film or a filmstrip to introduce the simple machines. (see instructional materials, page T13)
— An activity to involve all the students will have you group the students into six groups. Each group is given the name of one of the simple machines. Each group is to prepare a presentation based on their simple machine. These presentations might involve:
(a) models of their machines
(b) demonstrations
(c) a song or a poem
(d) costumes depicting their machine

#### Inclined plane (pages 105-107)

#### "Finding Out" (page 106)

#### How does an inclined plane help you do work?

— You may wish to have your students complete Activity 13 in their Activity Books (Textbook page 106).

*Sample answers:*

1. When the cart was rolled up the inclined plane. The height remained the same, and the distance the cart travelled was increased.
2. Less force. Because the distance travelled over the longer board was increased while the height remained the same.

#### An alternative "Finding Out" (page 106)

— See Worksheet 3 for an alternative to the 'Finding Out' on page 106. Objects to be pulled up the inclined plane will depend on what is available. e.g. a wagon, a sleigh, an old tire, a box of rocks...
— What unit of measure can be devised to measure the force used in each instance of this investigation? Discuss.
— Processes used include: *observing, measuring, comparing, inferring* and *predicting*.

### Wedges (pages 108-109)

— A local person may be able to help demonstrate the use of the wedge and hammer to split logs or tough wood.
— Try to provide the opportunity for the students to use the wedge to split wood.
— Activities that might be used to *observe* how the wedge reduces the amount of force needed to complete a task are:
  (a) *Compare* the force required to drive a common nail into wood by first hammering on the flat end and then turning the nail upside down and hammering on the pointed end.
  (b) *Compare* pushing two pencils into a cardboard carton using first a sharpened pencil and then a new unsharpened pencil.
  (c) Using a pair of wire snips cut the point off of several straight pins and have the student *compare* pushing these pins into a tackboard with pushing pins that have sharp points.
— Processes used include *observing, comparing* and *inferring*.

### Screws (pages 110-112)

— Obtain a car jack that uses the principle of the screw to demonstrate to the class. (Ask the school janitor if he could provide this type of jack.)
— As an art project, have the students sketch the design of the screw.
— Have a student investigate and report on the many different uses or screws about the classroom or school. Worksheet 4 may be used to record the observations.
— This activity will have students *observing, classifying, recording* and *comparing*.

### "Finding Out" (page 111)
### Which would you use, a screw or a nail?

— You may wish to have your students complete Activity 14 in their Activity Books (Textbook page 111).
— You may wish to make pilot holes for the screws with a drill before students carry out this "Finding Out".

*Sample answers:*

1. The screw.
2. The screw.
3. When a person would want to hold things in place but not as securely.
4. A screw would be used instead of a nail when a person would want things to be held securely in place.

### Levers (pages 113-117)

— Demonstrate the use of the lever for the students by lifting one end of your desk off the floor using a sturdy piece of lumber as a lever and a block of wood as the fulcrum.
— Have the students investigate the ease of the lift using the lever.
— Discuss other uses for the lever.

### "Finding Out" (page 115)
### Does moving the fulcrum make a difference?

— You may wish to have your students complete Activity 15 in their Activity Books (Textbook page 115).

*Sample answers:*

1. Yes.
2. Away from the load.
3. Close to the load.
4. Yes, if the load is near the fulcrum. However, if the load is far from the fulcrum, more force will be needed.

— Worksheet 5 might provide an alternative to the "Finding Out" on page 115. Styrofoam cups, or paper bags could be used in place of the plastic pails in this investigation.
— Worksheet 6 can be used to record the data from the alternate "Finding Out".

### Exploring on Your Own

| |
|---|
| There are different classes of levers. Learn about a first class lever, a second class lever, and a third class lever. Reference books will tell you about these levers. |

— After a discussion of the different kinds of levers as described on pages 116 and 117 of the text, some students may be given the task of researching the three 'classes' of levers.
— Worksheet 7 will provide another opportunity for the students to investigate the principles of the lever.
— The processes used include *observing, measuring, comparing, predicting* and *inferring*.

### Wheel and Axle (pages 118-122)

— Ask the students to bring items to school that have a wheel and an axle. e.g. wagons, baby carriages, tricycles, toys, bicycles, old clocks. Display the items in one area of the classroom.
— After a discussion of the many types of wheels and axles on pages 118-122, students can:

1. Make sets of wheels and axles using jar lids, tin lids, plastic lids (put two together) or heavy cardboard for wheels and dowelling or pieces of broom handles for axles. Test how far the wheels will roll.
2. Investigate how a wheel and axle will turn freely as part of a machine by constructing a wagon with wheels and axle as explained on Worksheet 8. Processes used include *observing, measuring* and *hypothesizing*.
3. Make a drawing of a particular type of wheel they have observed.
4. Write a poem about 'wheels'.

"Finding Out" (page 119)
Which is better, a large wheel or a small wheel?

— You may wish to have your students complete Activity 16 in their Activity Books (Textbook page 119).

*Sample answers:*

1. When the force is far from the axle.
2. Using a large wheel means the force is far from the axle. Thus, less force is needed.

Extension activity (page 119)

— an extended activity of the investigation of the wheel is to determine how far a wheel will travel in one turn. See Worksheet 9. Processes involved include *observing, measuring, predicting, recording data, interpreting data* and *hypothesizing.*

"Finding Out" (page 122)
How do gears make other gears turn?

— You may wish to have your students complete Activity 17 in their Activity Books (Textbook page 122).
— Bottlecaps may be used to replace the cardboard gears in this "Finding Out".

*Sample answers:*

1. Faster. The smaller gears have fewer teeth.
2. The next gear will turn counterclockwise. The other gear will turn clockwise.
3. I could set up a gear so that it can turn another gear. The axle of the second gear can be the axle for a wheel. When I turn one gear, the second gear and the wheel will turn.

— The opportunity to see how gears reduce work can be provided.

1. Arrange a visit to a local car repair shop where a gear box can be observed.
2. Locate a food beater or a carpenter's hand drill to show how a gear system works.
3. Remove the cover of an old clock to show the gear mechanism.
4. Have the gear system of a ten-speed bicycle explained.

Pulleys (pages 122-125)

— the pulley changes the direction of the force applied.
— after a discussion of the use of the pulley in the pictures on page 123, ask the school janitor to demonstrate the use of the pulley to raise and lower the school flag.

"Finding Out" (page 124)
How can you move things with a pulley?

— You may wish to have your students complete Activity 18 in their Activity Books (Textbook page 124).

*Sample answers:*

1. By pulling on the string that goes around the pulleys, I can turn the pulleys and move the attached load to the other side of the room.
2. By putting a pulley near the ceiling and by putting a string around the pulley, I can put the load on one end of the string and pull on the other string to raise the load to the ceiling.
3. I can put a string around the pulley. Then I can attach the load near the pulley and pull the load down to the floor.

Summary—Simple machines

— Worksheet 10 will provide a summary of the simple machines.

Chapter 3: Teams of machines, pages 126-131

— A collection of compound machines might be gathered for a classroom display for a week.
— After reading about and discussing compound machines found on pages 126-128, have students complete Worksheet 11. The compound machines listed on this worksheet might be the machines that are displayed in the class.
— This worksheet should emphasize the concept that compound machines are made up of two or more simple machines.

Chapter 4: Why work at all, pages 132-139

— After a discussion of the machine shown on page 132, the students could design a machine—e.g. a machine to comb your hair.
— Students could research a famous inventor and the machine this person developed.
— Worksheet 12 could be used to list three questions that the student wants answered.

Force of Gravity (page 133)

— A space vehicle, must reach a speed of approximately 40 000 km per hour in order to overcome the force of gravity that pulls things to the earth.
— A film or video tape that explains the three-stage rocket that is used to propel space vehicles into space might be shown to the students.
— An activity to consider the pull of gravity would have the students throwing softballs into the air and measuring the time from when the ball leaves the hand until it hits the ground.

A Force to Start Things Moving (page 135)

— Worksheet 13 provides an activity that has the students considering the wind as a force to start things moving.
— Processes used include *observing, measuring, comparing* and *inferring.*

Friction (pages 136-139)

"Finding Out" (page 138)
How can you change the amount of friction when doing work?

— You may wish to have your students complete Activ-

ity 19 in their Activity Books (Textbook page 138).

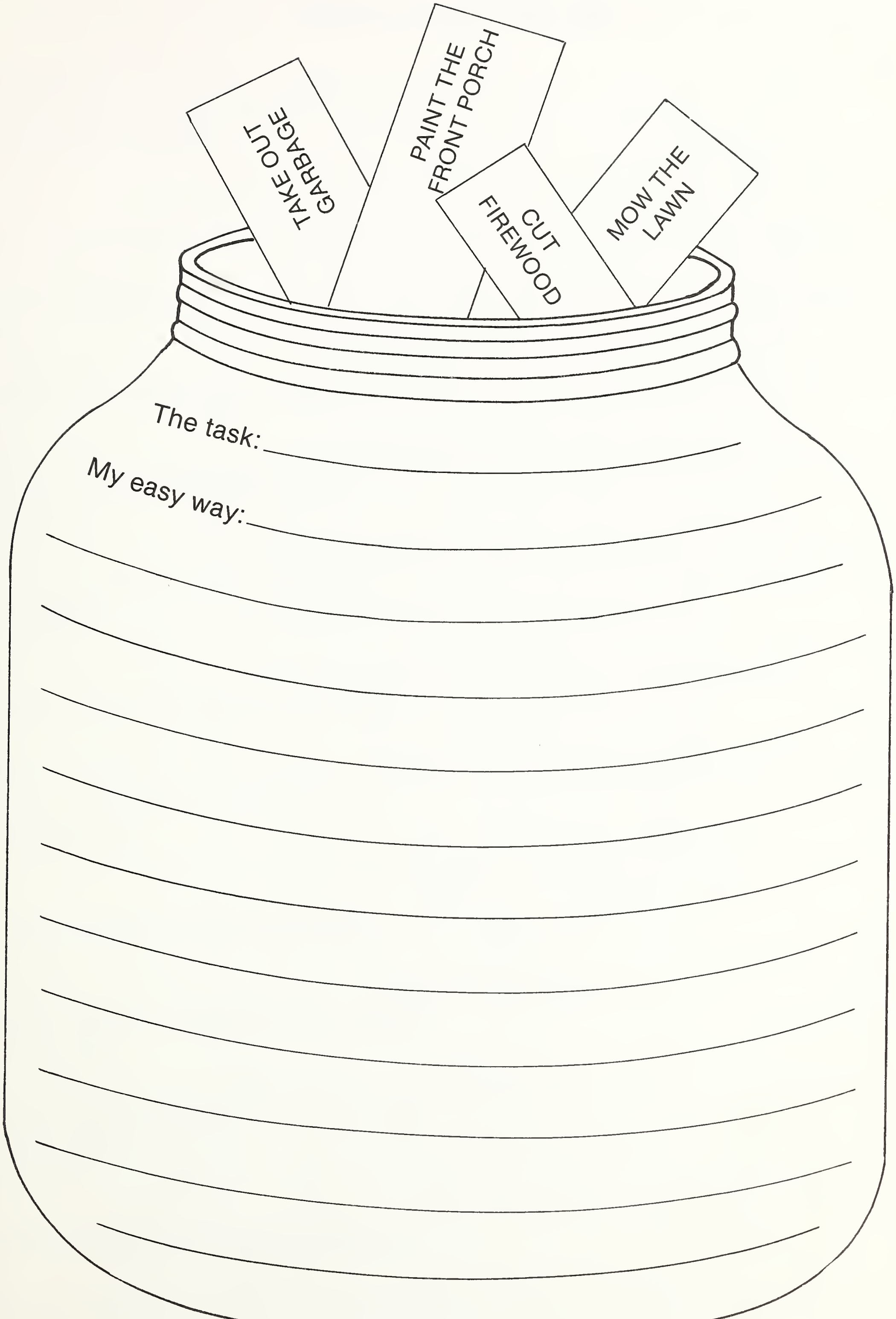
*Sample answers:*

1. The box with the sandpaper and all the rocks will make the most friction. The surface is the roughest, and the force is the greatest.
2. The least amount of friction will be made by the box with waxed paper and no rocks. The surface is the smoothest, and the force is the least.
3. To decrease the friction, put aluminum foil on the board and add a few drops of oil. To increase the friction, cover the board with rough sandpaper.

Extension activity (page 138)

— You may wish to use Worksheet 14 to extend the Finding Out on page 138.

— After reading and discussing pages 136, 137 and 138, the students may investigate friction using toys on an inclined board.



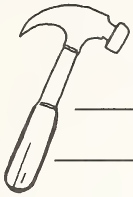

Work and Machines, Worksheet 1

# FORCE AND WORK

Consider each of the ‘happenings’ listed below and decide:

1. how much force is applied (much, some, little)
2. if work is done (yes or no)

| This happened: | How much force? | Is work done? |
|---|---|---|
| Keith carried his lunch to school. | | |
| Mary pushed the car but it would not move | | |
| Mr. Smith lifted a heavy motor onto the bench | | |
| Helen kicked the ball down the field | | |
| Harry tried to lift the window but was unsuccessful | | |
| The baker loaded his truck quickly | | |
| John tried to lift the barrel but it would not move | | |
| After much effort Helen’s team won the tug-of-war | | |
| Sue set a new record for the high jump | | |



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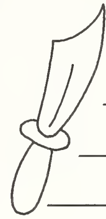

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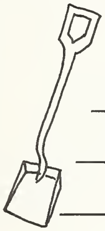

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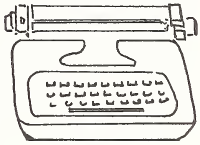

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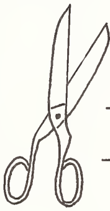

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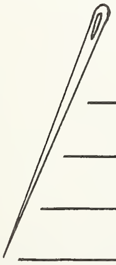

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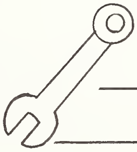

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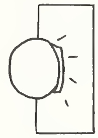

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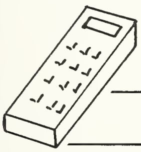

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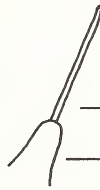

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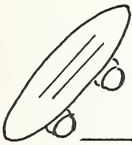

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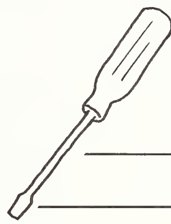

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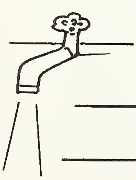

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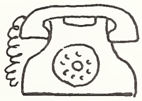

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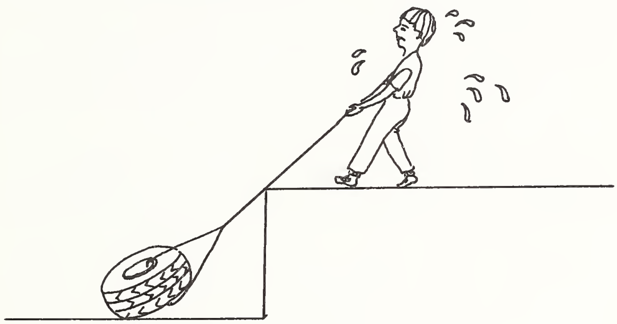
# Working it out...

**"Finding Out" alternative (Page 106)**

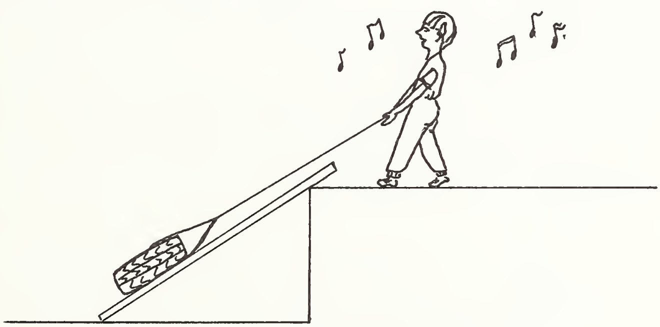
**How does an inclined plane help you do work?**

You will need: 10 metres of heavy rope, an incline or a terraced slope, a board or a piece of heavy plywood, an old tire.

- attach the tire to the rope
- try to pull the tire from one level to the higher level



- make an inclined plane with the board
- try to pull the tire from one level to the higher level up the inclined plane

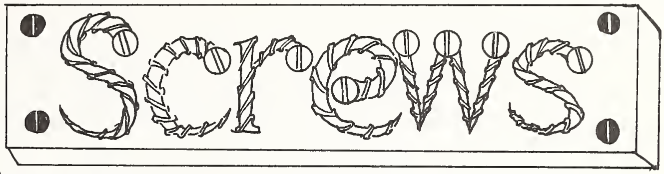


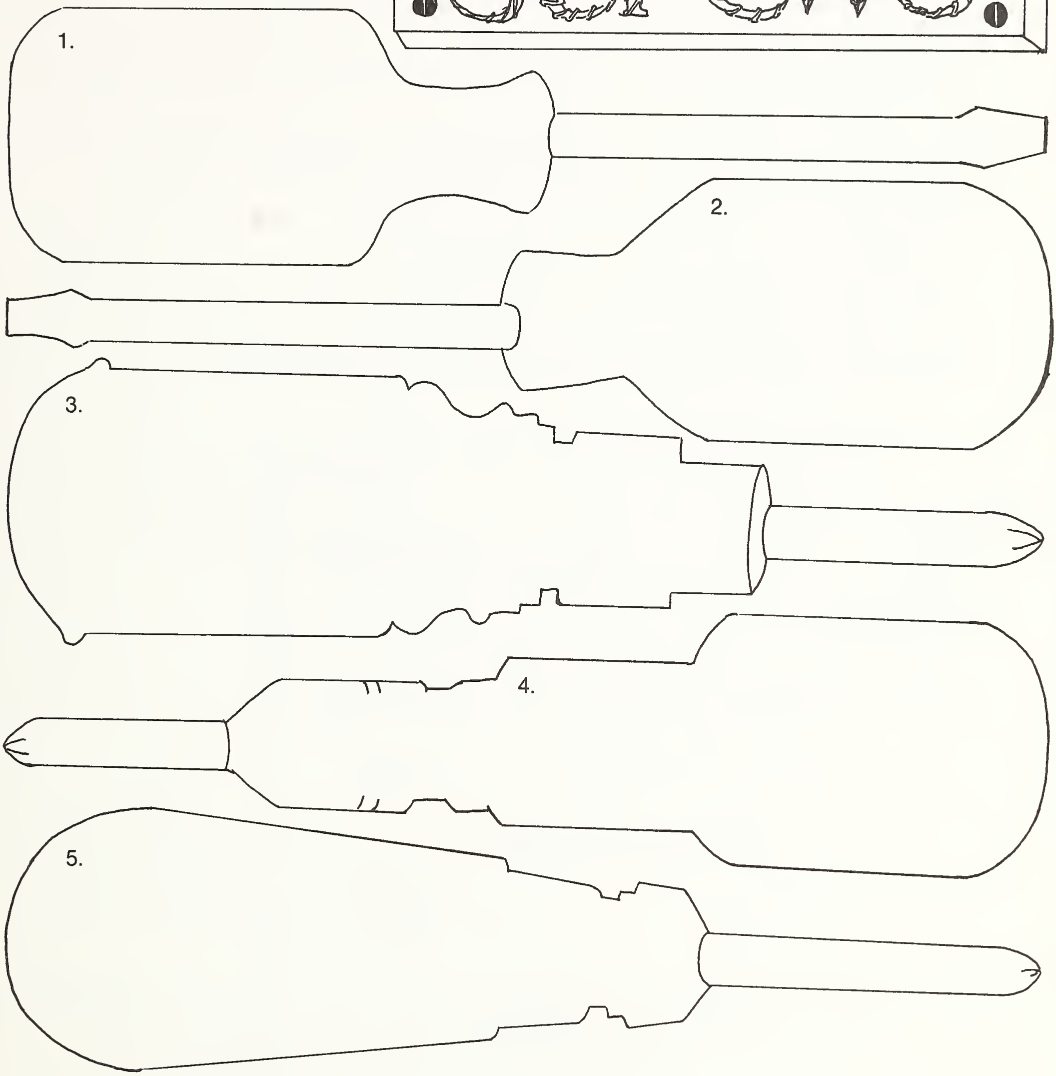
Which pull needed less force? Why?

How can you measure the force needed for each pull?

Work and Machines, Worksheet 3

I have observed screws used for these purposes:




I think screws hold better than nails because ______________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

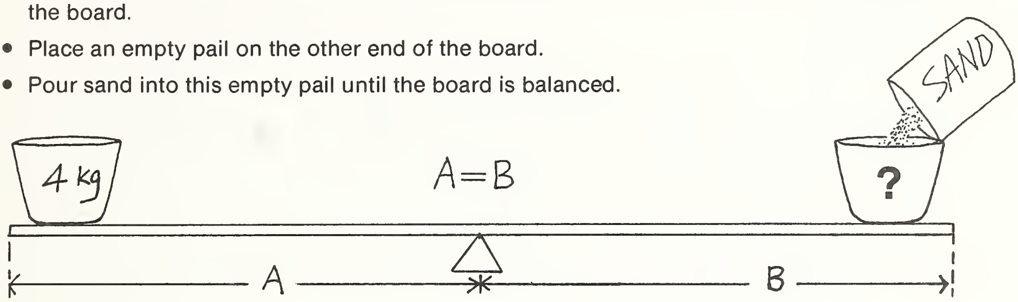
Work and Machines, Worksheet 4

**"Finding Out" alternative (Page 115)**

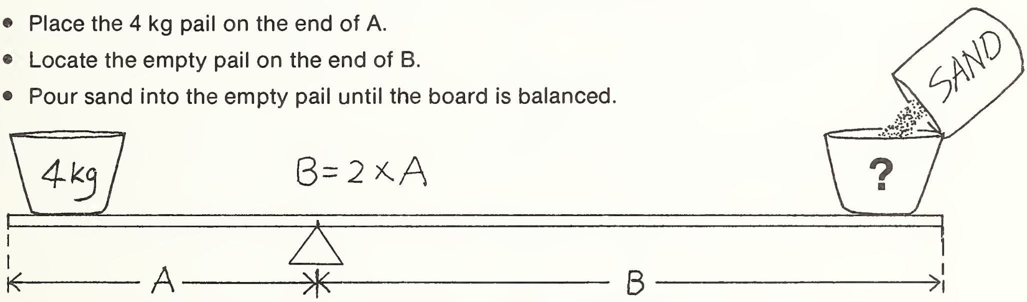
**Does moving the fulcrum make a difference?**

You will need: two plastic pails, a bag of sand, a spring scale, a board, a fulcrum.

- Pour sand in one pail so that the total weight of the sand and pail is 4 kg (small rocks can be used in place of the sand).
- Place the 4 kg pail on one end of the board that rests on a fulcrum situation at the midpoint of the board.
- Place an empty pail on the other end of the board.
- Pour sand into this empty pail until the board is balanced.




- Weigh this pail.
- Move the fulcrum so that the distance A is one-half the distance of B.
- Place the 4 kg pail on the end of A.
- Locate the empty pail on the end of B.
- Pour sand into the empty pail until the board is balanced.




- Weigh the pail.
- Move the fulcrum so that the distance A is one-third of the distance B.
- Repeat the process to balance the board.
- Weigh the newly-filled pail.

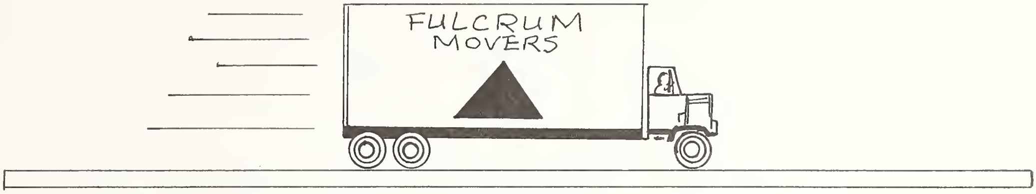
**Discuss:**

— How does the force needed to balance the board change as the fulcrum is moved?

— What would happen if the 4 kg pail were replaced with a 6 kg pail? an 8 kg pail?

Complete Worksheet 6

Work and Machines, Worksheet 5





**Distances**


| | A | B | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**My Conclusion:** ______________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

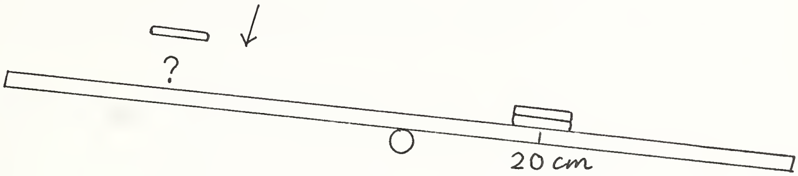
______________________________________________

______________________________________________

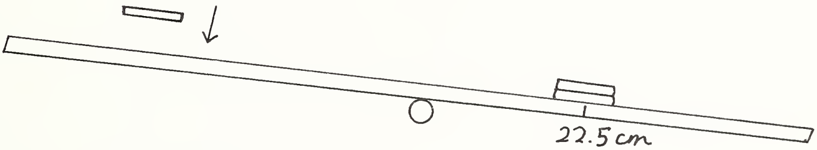
# Balancing the Lever

- Place a 30 cm ruler on a pencil. Make the lever balance on the fulcrum.
- Something to try:

**Test 1. Place two pennies on the 20 cm mark of the ruler.**



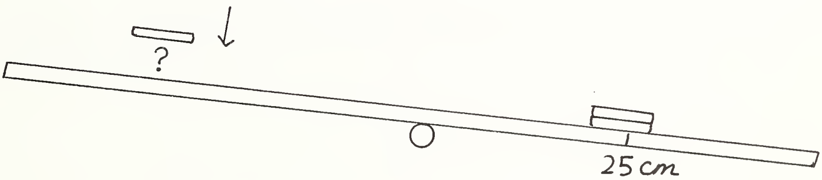

**Test 2. Place two pennies on the 22½ cm mark.**




Can you balance the lever with one penny?

Where did you place the one penny? ________

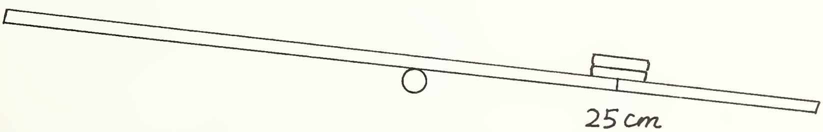
**Test 3. Place two pennies on the 25 cm mark.**




Can you balance the lever with one penny?

Where did you place the one penny? ________

**Test 4. Place two pennies on the 25 cm mark.**




Can you balance the lever without moving the pennies or adding more pennies?

- Set up some tests for others to try.

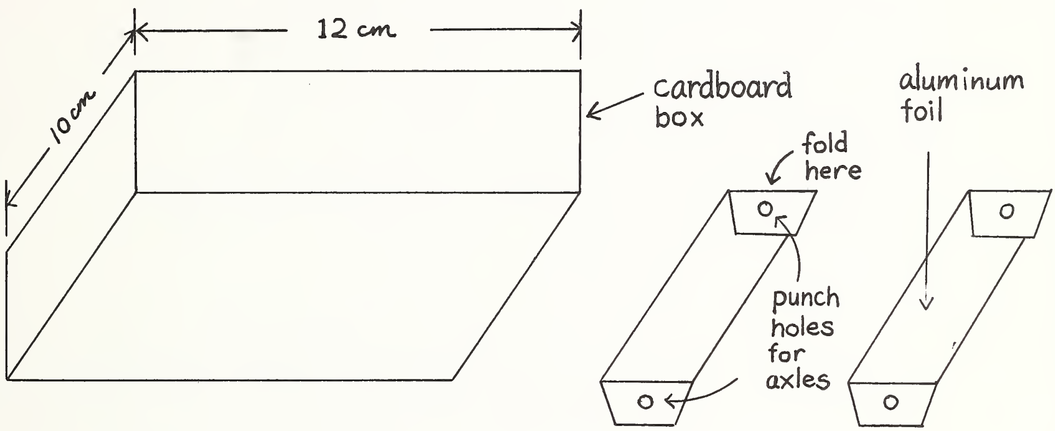
Work and Machines, Worksheet 7

## INVESTIGATION

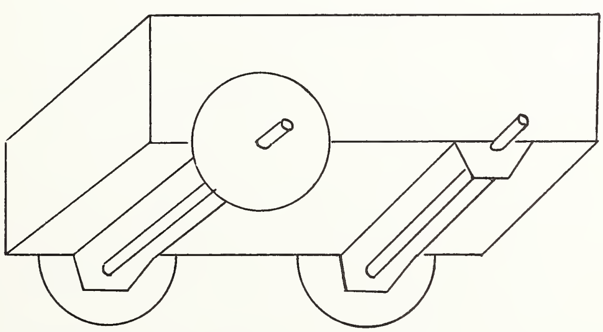
How do a wheel and an axle help to move a vehicle?

You will need: heavy pulpboard, straws, heavy aluminum foil (cut sturdy aluminum pie plates), cellulose tape.

- Construct a cardboard box as shown. Sizes shown are suggested only.
- Cut out of aluminum foil two sets of axle holders the width of the cardboard box.




- Tape axle holders to the bottom of the box.
- Slide the straw through the punched holes.
- Attach cardboard wheels to the straws with glue so that the wheels will not turn on the straws. A piece of steel rod (coat hanger) can be used in place of the straws.
- Test the movement of your vehicle.

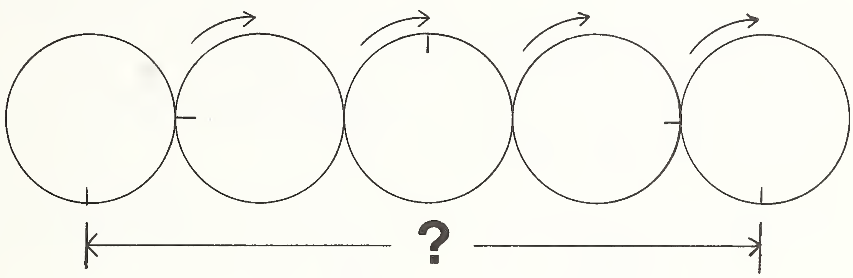


Question: How can the wheels and axles be made to turn more freely?

## INVESTIGATION

How far will a wheel travel in one complete turn?

You will need: wheels of several different diameters, a ruler or tape measure, a recording sheet.



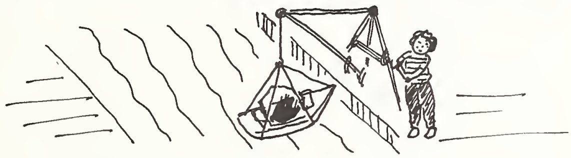
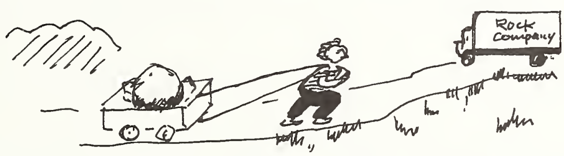
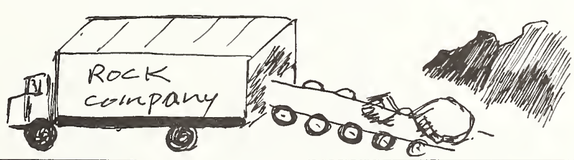
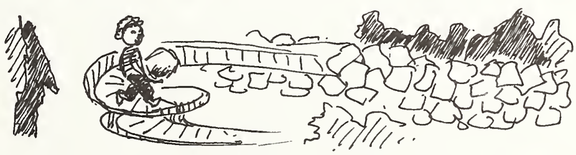

- Collect or make wheels of different diameters.
- Turn each wheel through one complete turn along a flat surface.
- Measure how far each wheel travelled and record the data.
- Complete the record sheet.

| How far will a wheel move in one complete turn? | | |
|---|---|---|
| **DIAMETER OF THE WHEEL** | **DISTANCE THE WHEEL MOVES** | **CONCLUSION:** |
| | | |
| | | |
| | | |
| | | |

# WHICH MACHINE?

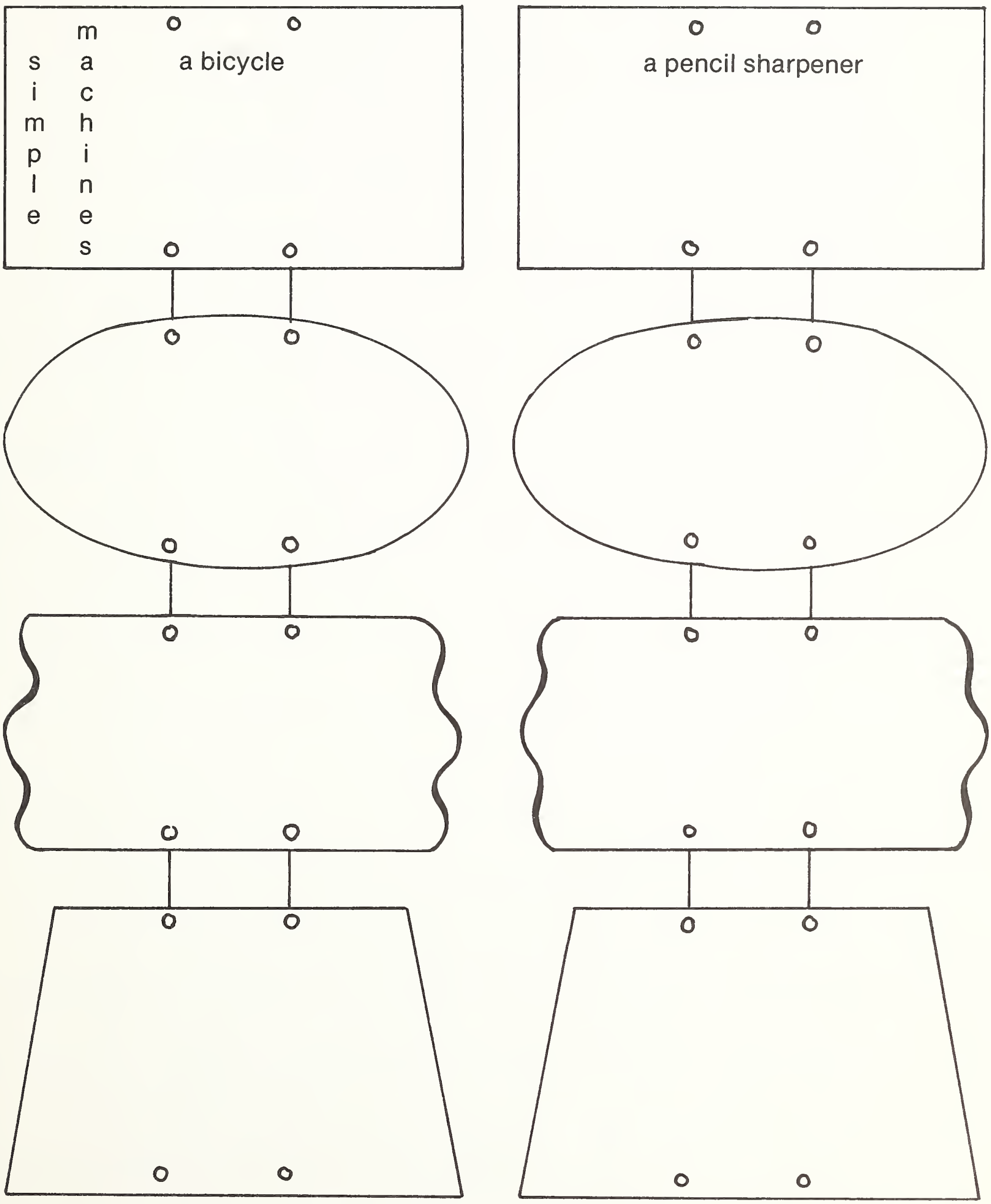
Match the task and the machine.

A. to split a log
B. to overcome stairs in a wheelchair
C. to make wooden furniture
D. to carry machines from one place to another
E. to raise a boat out of the water
F. to hold two pieces of wood together
G. to chew meat
H. to hold a door open
I. to remove a lid from a paint can
J. to raise a flag on a flagpole
K. an inclined plane wrapped around a cylinder
L. to change the direction of the force applied
M. two inclined planes combined
N. to pry a buried root loose

| | | |
|---|---|---|
| lever |  | I, N |
| pulley |  | |
| wheel and axle |   | |
| inclined plane |   | |
| screw |  | |
| wedge |  | |

# COMPOUND MACHINES

List the simple machines found in each compound machine



# RESEARCH

Machine to research ______________________________

My questions:

1. ______________________________

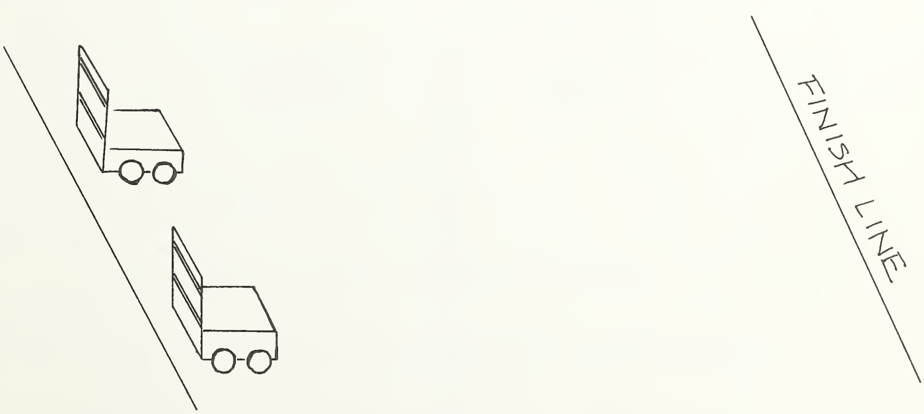
Answers:

Work and Machines, Worksheet 12

# A Contest in the Wind

You will need: A vehicle as shown on Worksheet 8, balsa wood or equivalent for the mast and cross arms, cloth or plastic for the sail.

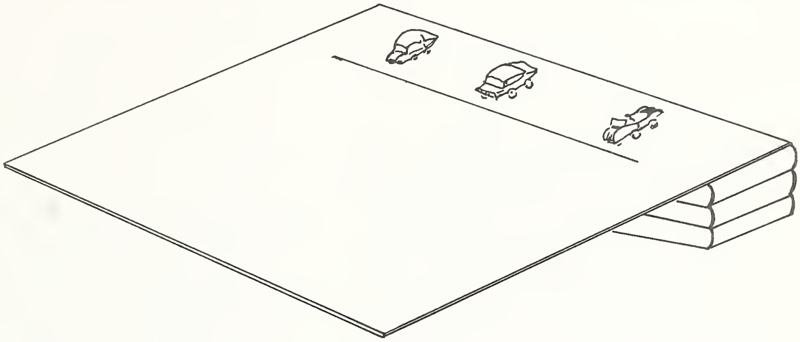

- Add a sail to the vehicle
- On a windy day, race your vehicle against classmates' vehicles.




Work and Machines, Worksheet 13

# Overcoming Friction

- Compare the distances travelled by toys that are released on an inclined plane.



Why do the vehicles stop?

How can the vehicles be made to go farther?

- Make a chart to record and compare the distances travelled by a number of toys.

| VEHICLE | DISTANCE | | |
|---|---|---|---|
| | 1ST TEST | 2ND TEST | 3RD TEST |
| NUMBER 1 | | | |
| NUMBER 2 | | | |
| NUMBER 3 | | | |
| | | | |

# Unit 4: Solids, Liquids, and Gases

**Pages 144-191**

## UNIT OVERVIEW

### Concept Development

In the preceding levels of the program, the following concepts were introduced and developed:

Heat energy can change the state of an object. When heat energy is added to a solid, it changes its state and becomes a liquid. Further heating may cause the liquid to change into a gas. Taking heat energy away from the object (cooling) may reverse the process. In general heating matter causes objects to expand and cooling causes objects to contract.

This unit is meant to further introduce and develop a student's understanding of matter — its forms, its structures and its changes. An awareness of the nature of matter is necessary if students are to have some understanding of their environment.

Chapter one introduces the word "matter" and defines it as anything that takes up space. The concept that all matter is made up of molecules is also introduced in this chapter. Chapter two discusses the three states of matter — solids, liquids and gases — and points out certain characteristics inherent in each state. Changes in the state of matter are outlined in the third chapter. Chapter four presents information on the differences between physical and chemical changes in matter.

### Process Development

In the first three "Finding Out" activities students carry out some *investigations* to show that matter takes up space. On page 154, students *observe* and *compare* the amount of space taken up by different objects by placing them in a container of water and *measuring* the rise in water level. Then they are asked to change the shape of some of the solids and *hypothesize* if this will alter the amount of space taken up by the solids. Before doing this investigation, you may wish to discuss factors that will affect the accuracy of the measurements taken. The narrower the container that is used, the more accurate the readings will be. Students then place liquids in a number of different shaped containers (p. 156) and they *observe* that liquids take up the shape of the container. From this observation, students *hypothesize* that the shape of the liquid is dependent on the shape of the container holding it. On page 161, students *observe* that water doesn't enter a glass when it is pushed upside down into a container of water. When the glass is turned over, they observe bubbles rising to the top and *infer* that the bubbles are escaping air. After students have completed these three "Finding Outs", you may wish to pose this problem: "Can two objects occupy the same space at the same time?" You may wish to have your students *design an investigation* to prove their *hypothesis*.

Changes in the state of matter are then investigated by students. In the "Finding Out" on page 165, students *compare* the amount of heat needed to melt different solids. You may wish to discuss with students some of the *variables* that will affect melting in this investigation (air temperature, body temperature, size of candle, amount of time). Students could consider ways of *controlling these variables* for each solid that they melt. From their data, students *hypothesize* that melting is dependent on the make up (molecular arrangement) of objects.

Students then heat some water (p. 168) and *observe, collect data* and *measure* changes that occur. Condensation is investigated on p. 172. Students *compare* the formation of water vapour on a can that has water and a can that has water and ice. They observe that water appears first on the can with ice in it. From this observation they *infer* that water vapour will condense faster on a cooler object and that the water droplets that form on the can come from the air.

Physical and chemical changes in matter are investigated in the "Finding Outs" on pages 179, 180 and 186. Students grow crystals from a liquid (p. 179) and *infer* that crystals form as the liquid evaporates. (Physical change). Students then *observe* changes in colour, state, taste and position by mixing some solids and liquids (p. 180). After *observing* how a solid reacts with water they *predict* how the solid will react with a different liquid. You may wish to have students *hypothesize* which of these changes are chemical changes and which are physical changes. On p. 186, students *observe* the chemical and physical changes that occur when a candle burns. They make *inferences* about what causes these chemical and physical changes.

### Related Units

Heat and Temperature *Blue Book (3)*
Matter and You *Red Book (6)*
Changes in Energy *Red Book (6)*
Energy, For Work and Motion *Exploring Matter and Energy (7)*
Science: Something People Do *Exploring Matter and Energy (7)*

### Materials and Advance Planning

The following list includes the materials that a student, or in some cases a group of students, need to carry out the activities in this unit. In some instances, other materials may be substituted for those on the list.

Measuring cup; 5 different-shaped solids (pick some solids that can change shape easily); different liquids such as water, vegetable oil, vinegar and rubbing alcohol; different-shaped containers such as a jar, bowl, can and pan; large clear container of water; food colouring; clear drinking glass; ice cubes; butter; wax; solid shortening; plastic bags; pan; candle; matches; burner or hot plate; 2 tin cans; plastic sandwich wrap; 2 or 3 pieces of charcoal; laundry bluing; table salt; ammonia; small bowl; large plate; large bowl; sand; instant tea; sugar; 4 jars; spoon; large jar; potholder.

The additional activities suggested in the Resource Guide require: paper clips, popsicle stick; sewing needle 2 small squares of glass; medicine dropper; empty pop bottle; 10 L pail; ice or dry ice; calcium chloride (or table salt); hammer; tin can; alum; epsom salts; borax; copper sulphate; sodium hyposulphate; 250 mL glasses or clear plastic containers.

## BACKGROUND INFORMATION

### Chapter 1: It's a matter of molecules, pages 146-151

Objects in the environment may differ from each other in many ways. Objects may be living or nonliving. They may also differ in shape, colour, state and size.

Objects may also be alike in certain ways. One way in which objects are alike is that they take up space. Any object that takes up space is called matter.

Another way in which objects are alike is that all matter is made up of molecules.

### Chapter 2: The states of matter, pages 152-162

Matter can exist in three states: a solid state, a liquid state and a gaseous state.

Solids may differ from each other in properties such as size, shape and colour.

However solids have certain common properties. One such property is that solids have their own shape. The reason for this is because the molecules making up a solid are very closely packed, which does not allow the molecules to move.

Another property is that when the shape of a solid is changed, it will still take up the same amount of space. For example, a sheet of paper has a definite shape, that takes up a certain amount of space. If the sheet is crumpled up, the shape is changed, but the amount of space taken up remains the same.

Liquids are also alike in certain ways. One way they are alike is that they do not have a shape of their own. The reason for this is that molecules are farther apart than those that make up solids. This allows the molecules in liquids to move. Therefore, liquids take the shape of the containers in which they are placed.

Another way liquids are alike is that they normally take up the same amount of space. the amount of space a liquid takes up remains the same regardless of the size or the shape of the container into which the liquid is poured.

Gases, like solids and liquids, are alike in certain ways. One way in which gases are alike is in the density of the molecules that make up gases.

The molecules that make up gases are very far apart. As a result, the molecules are able to move about quite freely. For this reason, gases have no shape of their own.

Another way in which gases are alike is that they can move about by themselves. Because of the freedom of the molecules making up gases, gases do not always take up the same amount of space.

### Chapter 3: Changing the states of matter, pages 163-174

Under certain conditions matter can be changed from one state to another. One way in which matter can be changed from one state to another is by adding heat energy.

When heat is added to a solid such as ice, the heat causes the molecules making up the ice to move faster than they did before heat was added. This increase in movement causes the ice to melt, and change its state to water. When heat is added to water, the heat causes the molecules making up the water to move faster than they did before heat was added. If enough heat is added, the water will boil.

As the water boils, the molecules making up the water move very fast. Those molecules also move farther away from one another, resulting in the formation of a gas called water vapour. The process by which a liquid is changed into a gas is called evaporation. Sometimes a liquid may evaporate without boiling.

The temperature at which a liquid boils is called its boiling point. However, liquids that boil do not do so at the same temperature. In addition, the boiling point of a liquid can vary with air pressure. The atmosphere, or the air pressure, pushing down on the surface of the liquid has a profound effect on the boiling point of any liquid. For example, air pressure is less at high altitudes than it is at low altitudes. Therefore, liquids boil at a lower temperature at high altitudes than at low altitudes because of the lower air pressure. Another way in which matter can be changed from one state to another is by taking heat energy away. When heat is taken away from a liquid, the molecules making up the liquid move more slowly, often resulting in a solid. Water, for example, is changed into ice when enough heat is taken away.

Most gases also can be changed into a liquid by taking heat away. For example, during the summer

drinking glasses containing something cold often "sweat". This "sweat" results from the heat being taken away from water vapour in the air by the coolness of the glass. When the heat is taken away, the molecules making up the water vapour in the air slow down, changing the water vapour into the small drops of water that collect on the outside of the drinking glass. The process of water vapour being changed into water is called condensation.

Many kinds of matter can be changed into any of the three states. For example, water can be changed into a solid, a gas, and back into a liquid. Some kinds of matter, however, cannot be changed into each state. For example, dry ice is a solid that changes directly from a solid to a gas called carbon dioxide. This kind of change in matter, which is typical of dry ice, is called sublimation.

### Chapter 4: Other changes in matter, pages 175-187

Changes in matter can be of two kinds. One kind of change is called a physical change, and the other kind is called a chemical change. One physical change in matter is a change in state. When a change in the state of matter occurs, the molecules making up the matter are not changed in any way. For example, when ice is changed to water vapour, the molecules remain the same. The only difference between the three states when a physical change occurs is how fast the molecules are moving.

Besides a change in the state of matter, a change in the size of matter is also a physical change. For example, most matter will expand when heat is added and will contract when heat is taken away, causing a change in the size of the matter. However, the molecules making up the matter are no different regardless of the expansion or contraction. Other physical changes in matter include changes in shape and in colour.

Although physical changes in matter do not change the molecules making up the matter, chemical changes do. Thus, when a chemical change in matter occurs, a different kind of matter is produced. Some examples of chemical changes are the burning of wood, the rusting of iron, the souring of milk, the digesting of food, and the tarnishing of gold and silver.

In some chemical changes such as the combining of hydrogen and oxygen to produce water, it may seem that new matter is created. In other chemical changes such as the burning of paper, it may seem that matter is destroyed.

However, the law of conservation of matter states that in ordinary chemical changes, matter is neither created nor destroyed, but only changed from one kind to another. For example, when hydrogen and oxygen combine to produce water, the same amounts of hydrogen exist, even though they have changed into a new kind of matter. Even with the burning of wood, which produces gases and ashes, the combined mass of the wood and the oxygen used to burn the wood is exactly the same as the combined mass of the ashes and the gases that are a result of the burning.

## TEACHING STRATEGIES

The purpose of the following activities and teaching strategies is to provide you, the teacher, with a wide variety of suggestions that can be used, together with the material presented in the textbook, to help develop the processes and concepts of this unit.

### Chapter 1: It's a matter of molecules, pages 144-153

#### Introduction (pages 144-147)

- —Pages 144-145 can be read and discussed. A discussion of page 144 could include the identification of the materials shown in the picture as well as a discussion of what purpose each material has.
- —Pages 146-147 deal with how things are different. It may be useful to point out or to have the pupils discover that the *qualities* of the objects discussed in the poem are opposites—square and round, blue and green, hot and cold, etc. The pupils as a class may identify and list other things that are different and the different qualities of these things. Using the class list of different things, each pupil could write a poem about different things.

#### What's the difference? (pages 148-149)

- —When reading and discussing pages 148-149 it may be helpful to not only identify things that are not the same but to also note how they differ. For example, people differ in height, weight, colour, appearance, etc.

#### Just alike (pages 150-151)

- —Pages 150 and 151 may be read and discussed. The things which were identified as being different on pages 148-149 could be used to show how they are also alike in some ways. For example, people are alike in that they occupy space, have the same number of body parts, have feelings, use their senses and so on.
- —To better understand and to remember the definition of matter, students could draw a cartoon called "*Matter*" using different characters each of which claims to be Matter. Each cartoon character could claim, "I'm Matter because I take up space." or some similar statement that says matter takes up space.

  The following dialogue for three characters could be provided:

  "I'm Matter because I take up space."

  "But I'm Matter because I take up space."

  "We are all Matter because we all take up space."

  An additional character who is invisible may be introduced. He is invisible because he is one molecule.

## Chapter 2: The states of matter, pages 152-162

### Introduction

— Page 152 can be read and discussed. The students will be familiar with water in each of its three states. From a discussion of the three states of water students may *infer* that the arrangement of the molecules in a substance determines whether it is a gas, liquid or solid.

— As a gas, the molecules move about very quickly as can be shown when steam is produced. As a liquid in a pond or stream, the water can be seen to move slowly in the form of waves. As a solid in the form of ice water cannot be seen to move. Students may also be helped to infer that for water to change from one state to another there must be heat or the lack of heat.

— A display of molecules in their three states could be set up in the classroom. The display could be entitled *Molecules in Their Solid State* (pencils, erasers, paper clips); *Molecules in Their Liquid State* (water, vinegar, fruit juice); *Molecules in Their Gaseous State* (soccer balls, inflated balloons, inflated plastic bags). As the study of this chapter progresses additional articles may be added to the display.

— Students could make their own displays by gathering or drawing pictures of each of the three forms of molecules.

### Solids (pages 153-155)

— Pages 153-155 may be read and discussed.

### "Finding Out" (page 154)
### How can you measure the space taken up by a solid?

— You may wish to have your students complete Activity 20 in their Activity Books (Textbook page 154).

— Putty, silly putty, or gum are good examples of solids whose shapes may be changed.

*Sample answers:*

1. No. The water level rose higher when large objects were put in the cup than when small objects were put in the cup.
2. Yes. When a solid has been changed in shape, it will still take up the same amount of space as it did while in its original shape.

### Liquids (pages 155-159)

— Pages 155-159 may be read and discussed.

### "Finding Out" (page 156)
### What shapes do liquids take?

— You may wish to have your students complete Activity 21 in their Activity Books (Textbook page 156).

*Sample answers:*

Yes. Liquids have no shape of their own.

### Extension activities (page 156)

— 1. As a supplement to the "Finding Out", page 156 you may wish to do the activity on Activity Card 1, "Which Container Holds More Liquid?" It may be useful to review the meaning of the word *predict* prior to beginning the activity. Predict in this case may mean to forecast or to make a scientific guess. You may wish to have your students use a single volume of water which they transfer from container to container.

— 2. You may wish to expand on the "Finding Out", (page 156) by investigating surface tension ideas. Begin by placing two drops of water on a nonporous surface and discuss with the students the reasons why the drops form a circular or partly spherical pattern. Water on a surface such as a table has molecules that pull on each other from all directions except for those molecules in the top layer. They are pulled on from below but they are not pulled by the air molecules above them. This pull from below makes the surface of the molecules behave like a very thin elastic skin.

— 3. Activity Cards 2.1-2.4 contain investigations involving surface tension. You may wish to set up one or two stations per activity and have groups of students rotate from station to station to perform the investigations or you may choose to demonstrate some of the investigations and have the students do the others.

  — In investigation 1, Activity Card 2, the water in the glass may be heaped or piled up because of the attraction which the water molecules hold for each other.

  — In investigation 2, Activity Card 2, the needle or other objects will float in the cold water because the attraction of the water molecules to each other creates a curved, elastic film upon which the objects rest. With the boiling water, the heat causes the molecules to move more rapidly thus weakening the attraction the molecules have for each other.

  — In investigation 3, Activity Card 2, the moistened pieces of glass are held together by the attraction of the water molecules for each other and the attraction between the water and the glass.

  — In investigation 4, Activity Card 2, the stick should begin moving forward as soon as it is placed on the water and continue to move for quite a while. If there was no soap on the stick, it would tend to remain in one place. Water molecules would cling to the surface of the stick evenly in all directions if there was no soap. The soap weakens the surface tension where it dissolves with water permitting the stick to be pulled forward. *Note*: there are two forces at work here—adhesion causing the

clinging of the water molecules to the stick, and cohesion causing the water molecules to pull on each other.

— A few drops of soap or detergent added to the water in investigation 2, Activity Card 2, will make it difficult to float the objects because the attraction between the water molecules at the water's surface will be weakened.

— 4. To increase the pupils' understanding of the behaviour of liquids, you may wish to do Activity Card 3, "Hot and Cold Molecules." The molecules in the bottle of hot water are moving faster than those in the cold water. They take up more space, so the hot water is lighter. Gravity pulls the heavier, cold water down so the cold water forces the lighter, heavier water up. After a while the water should be thoroughly mixed and look alike in both bottles.

### Gases (pages 160-162)

— Pages 160-162 can be read and discussed.

— To assist your pupils to understand the behaviour of gases you can do the following investigation. Place some mothballs on a dish at the front of the room. (Get mothballs or mothflakes with a strong odour.) Close the windows and doors and ask the students to sniff for the odour of mothballs. Ask pupils to raise a hand as the odour reaches them. The odour should reach the nearest noses first. You may wish to time how long it takes for the odour to travel to various parts of the room. (Perfume or an onion may be used in place of the mothballs.) To explain the behaviour of gases you may point out that the molecules in a gas vibrate rapidly causing them to be moved into the air. They are diffused or spread out through the air. As they spread they reach the nearest pupils first. Because the molecules are not widely diffused, the nearest pupils should get the strongest odour and those pupils farthest from the mothballs will probably get a weaker odour.

### "Finding Out" (page 161)
### How can you show that gases take up space?

— You may wish to have your students complete Activity 22 in their Activity Books (Textbook page 161).

*Sample answers:*

1. Air rose to the top of the water.
2. Yes. I can see the lighter areas where the gas takes up space.
3. Different gases in the air.
4. If I insert a balloon in a can of water, it may not move the water much. But if I blow up the balloon and force it into the water, the water may be forced out of the can.

### Extension activity (page 161)

— To supplement the "Finding Out" (page 161) you can use Activity Card 4, "Do Gases Take Up Space?" The dime on the bottle should lift or pop up after the bottle has been held for a short while. The hands on the bottle cause the air inside the bottle to heat and expand. The expanded air forces the dime to lift and release some air. In some instances you may see condensation form inside the bottle.

— You can ask the students to *predict* what will happen to the dime before you begin.

### Review activity for Chapter 2

— Worksheet 1, "The Molecules of a Solid, Liquid and a Gas" may be used to show that the molecules of a solid are held together more closely than are the molecules of a liquid. Similarly the molecules of a liquid are held together more closely than the molecules of a gas.

## Chapter 3: Changing the states of matter, pages 163-174

### Changes made by adding heat (pages 164-166)

— Pages 164 through 166 can be read and discussed. Prior to doing the "Finding Out" (page 165), it may be useful to have the pupils identify and group solids, liquids and gases by using Worksheet 2, "Classifying Solids, Liquids and Gases." The class can be divided into groups with each group identifying as many solids, liquids and gases as possible, or the class may be divided into three groups. One group will find and list the things around the school that are in solid form. Another group will find and list things that are in liquid form. The third group will list things they find in gaseous form. A time limit may be necessary.

### "Finding Out" (page 165)
### How can you compare the amount of heat it takes to melt different things?

— You may wish to have your students complete Activity 23 in their Activity Books (Textbook page 165).

*Sample answers:*

1. The ice cubes and perhaps the butter and the shortening.
2. The butter and the shortening.
3. The molecules of some solids are held more tightly together than the molecules of some other solids. More heat is needed to change the molecules of a tightly held solid than is needed to change the molecules of a loosely held solid.

### Liquids to gases (page 167-168)

— Pages 167 and 168 can be read and discussed.

"Finding Out" (page 168)
What are some changes you can see in water as it is being heated?

— You may wish to have your students complete Activity 24 in their Activity Books (Textbook page 168).

*Sample answers:*

1. The water rises and moves around quickly in the pan.
2. Yes. The bubbles are water vapour. They rise from the bottom of the pan and break at the water level.
3. Steam rising in the air.
4. No. The water changed into steam and became part of the air.

— To supplement the "Finding Out" (page 168) hold a piece of aluminum foil above the pan when the water is boiling. The water droplets formed on the foil will be evidence that the water has left the pan. Prior to holding the foil over the pan ask the pupils to write down their prediction of what will happen.

Solids to gases (page 169)

— The information on evaporation (page 169) can be read and discussed.
— Activity Card 5, "Evaporation" can be used to provide first hand experience with evaporation.
— Mothballs may be identified as another example of a solid that can change straight to a gas. The fact that the odour of mothballs travels through the air is evidence of the gaseous form of mothballs.

Changes made by taking heat away (pages 170-173)

— Pages 170-173 can be read and discussed.

"Finding Out" (page 172)
How can you get water from the air?

— You may wish to have your students complete Activity 25 in their Activity Books (Textbook page 172).

*Sample answers:*

1. Yes. The can with the ice.
2. Water formed from water vapour in the air. The change from a gas to a liquid takes place faster around cooler objects.
3. Whenever I get a cold drink in a glass, water vapour from the air will form beads of water on the glass.

Extension activity (page 172)

— As a supplement to the "Finding Out" (page 172), you may wish to use Activity Card 6, "Making Snow." Calcium chloride works better than ordinary table salt because it will make a freezing mixture at about -8°C.

— If dry ice is available you may scrape the surface of a cake of ice with a knife blade, (wear heavy gloves as dry ice is about -0°C). Hold the knife blade over the cloud that you form by breathing into the can. Tap the knife so that the dry ice crystals fall through the cloud. A vapour trail will appear which will eventually become tiny crystals. The crystals will grow to become tiny snow flakes.
— Dry ice is "seeded" into clouds in the summer time to produce rain.
— When you read page 173 you can point out that dry ice is really carbon dioxide which has been solidified.
— Page 174 can be read and discussed. Worksheet 3 "How Melting and Freezing are Related" may help the pupils to understand that adding or removing heat are responsible for melting or freezing.

Chapter 4: Other changes in matter, pages 175-187

Other physical changes (pages 175-180)

— Pages 175-180 may be read and discussed. Ask the pupils to gather pictures of the different kinds of physical changes so that the class may arrange a display of physical changes. To assist the pupils in their search for pictures ask them to look for specific physical changes such as:

changes in state—water to ice or powder to a liquid
changes in size—corn to popcorn
changes in shape—a pane of glass to glass fragments
changes in colour—brought about by painting or covering with wallpaper or paint

"Finding Out" (page 179)
Can a solid be made to "grow" from a liquid?

— You may wish to have your students complete Activity 26 in their Activity Books (Textbook page 179).
— Colour could be added to the crystals, by placing red, blue or other food colouring into different parts of the bowl.
— You may wish to have your students use a hand lens to observe the crystals.

*Sample answers:*

After one day small crystals begin to grow on top of the charcoal.
After two days, as more crystals grow, the amount of liquid in the bowl decreases.
After three days more crystals will grow until all the liquid in the bowl has evaporated.
After four days, since the crystals are very fragile, they may begin to crumble and turn to powder.

### "Finding Out" (page 180)
### What happens to some solids and liquids when they are mixed?

— You may wish to have your students complete Activity 27 in their Activity Books (Textbook page 180).

*Sample answers:*

1. Salt disappears in the water. Sand rests at the bottom of the jar. Tea spreads evenly throughout the water. Sugar disappears in the water.
2. Yes. The salt, tea, and sugar can't be seen.
3. Some may and some may not.
4. Answers will vary.
5. Answers will vary.

### Extension activity (pages 179 and 180)

— Activity Card 7, "Observing Crystal Shapes" provides an opportunity to see that crystals take various shapes and sizes.

### Some chemical changes (pages 181-187)

— Pages 181-187 can be read and discussed. You may wish to ask the pupils to gather pictures of chemical changes. A display of these pictures may help them to understand what chemical change is and how a chemical change is different from a physical change. Ask the children to look for pictures that show that matter is changed into different kinds of molecules in such events as breathing, eating, rusting, burning, cooking and the growth of plants.

### "Finding Out" (page 186)
### What changes can you see in a burning candle?

— You may wish to have your students complete Activity 28 in their Activity Books (Textbook page 186).

*Sample answers:*

1. The candle goes out. The flame uses up all the oxygen.
2. Heat causes the wax to melt and drip. When the wax is away from the heat, it hardens.
3. The wick burns and changes into black carbon.
4. There was no longer any fuel to join with the oxygen.

### Extension activities (pages 186-187)

— You may wish to extend your work with the "Finding Out" (page 187) by using Activity Card 8, "The Hottest Part of a Flame."

— To understand how burning takes place you can ask the pupils to identify the three states of matter in a burning candle. The wax cannot burn until it changes to liquid and is drawn up into the wick, where it is heated sufficiently to change the liquid to a gas which will then burn.

— Other ways of showing chemical changes are included in Activity Card 9, "Changing Sugar" and in Activity Card 10, "Cleaning Silverware."

— Be sure to closely monitor any activities with heat.

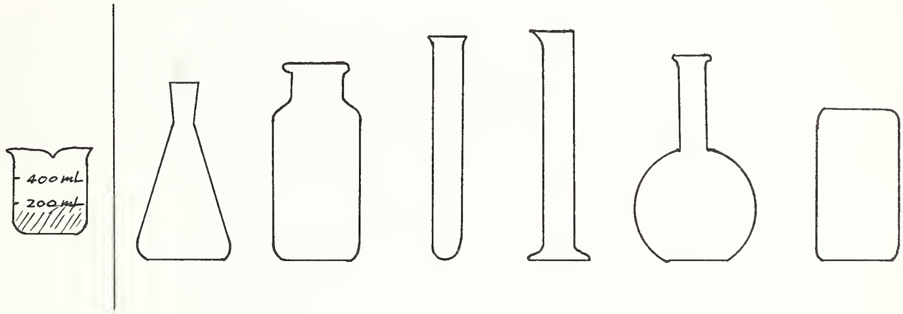
— In the activity "Changing Sugar", the hydrogen and oxygen in the sugar will be driven off in the form of water vapour, some of which will collect on the can. The remaining black mass will be carbon.

— In the activity "Cleaning Silverware", silver sulphide will be removed from the silverware and "attracted" to the aluminum pan.

# WHICH CONTAINER HOLDS MORE LIQUID?

You will need: several containers similar to those pictured below
food colouring
water
crayons

You may choose containers different from those below.




- Pour 200 ml of water into the beaker. Add a few drops of food colouring so that you may see the level clearly.
- Predict the level of the water in each container. Place a pencil mark on the side of the picture of each container where you think the top of the water will reach.
- Pour the water from the beaker into one of the containers.
- With a crayon colour the level reached by the water.
- Repeat these steps for each container.

Is the water level the same in each container?

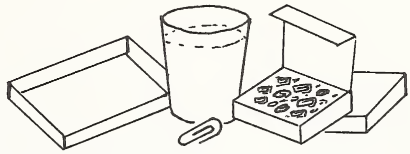
How many correct predictions did you make?

What shape did the liquid in each container take?

Solids, Liquids, and Gases, Activity Card 1

# FLOATING THINGS

1. You will need: a glass
   water
   a tray
   2 boxes of paper clips



- Fill a glass of water to the very top.
- Slowly drop paper clips into the glass, one at a time.
- Can you see the water build up at the top of the glass?
- Keep adding paper clips until the water spills over the glass into the tray.

  Why did the water build up?

• • • • • • • •

2. You will need: a small bowl or dish
   a sewing needle
   a dinner fork
   cold water

- Fill a bowl with cold water. Rub a sewing needle with your fingers and use a dinner fork to gently place the needle on the water.

  Can you make it float?
  Why?

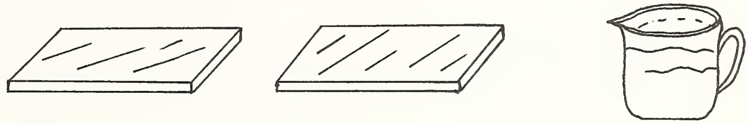
- If they are available you could try to float other objects such as a paper clip or a razor blade.
- Try the same investigation with boiling water instead of cold water. Have your teacher pour the boiling water for you.

  Were you able to float the needle?
  Why?

Solids, Liquids, and Gases, Activity Cards 2-1 to 2-2

# FLOATING THINGS

3. You will need: 2 small pieces of glass
   cold water

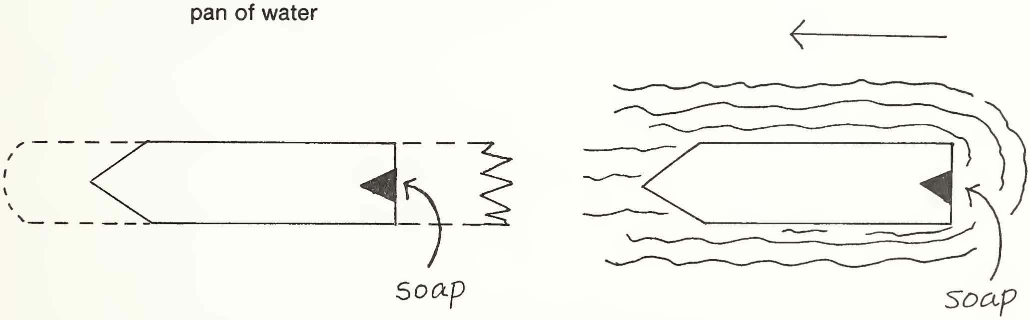


- Moisten the small pieces of glass and place them together.
- Try to pull them apart without sliding them sideways.,

  Were you able to pull them apart?

● ● ● ● ● ● ● ●

4. You will need: a flat popsicle stick
   a small piece of soap
   pan of water




- Use about 3 cm of the stick. Cut one end to a point and notch the other end. Place a small piece of soap into the notch.
- Set your stick with the soap in a pan of water.

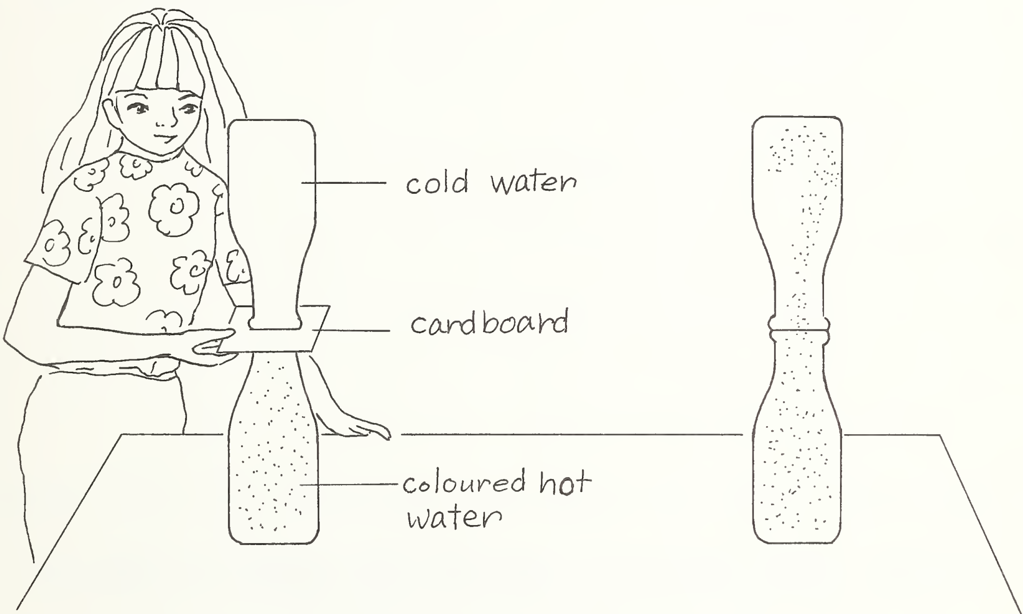
  What happens?

  Why?

# HOT AND COLD MOLECULES

You will need: two empty bottles
food colouring
hot and cold water
a small piece of cardboard
a large tray

- Fill one bottle with cold water. Fill the other bottle with hot water and add enough food colouring to darken the water.
- Work over the tray.
- Place the cardboard over the bottle of cold water. Then carefully turn it upside down to place it mouth down over the bottle of hot, coloured water.
- Slowly remove the cardboard.




What happens?

Observe the bottles again after a few minutes.
What happened?

## DO GASES TAKE UP SPACE?

You will need: an empty pop bottle
a few drops of cold water
a dime

- Place a few drops of cold water in the pop bottle.
- Moisten the dime and place it over the top of the pop bottle.
- Place your hands or the hands of a partner over the bottom of the pop bottle and hold the bottle for a few minutes.

Watch the dime. What happens to the dime?

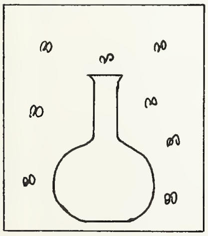
Why?

Solids, Liquids, and Gases, Activity Card 4

## THE MOLECULES OF SOLIDS, LIQUIDS, AND GASES

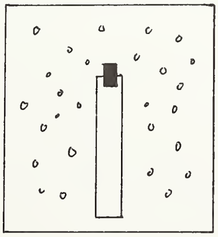
Use the information given below to help you decide which picture represents a solid, a liquid, or a gas. On the blank above each picture write the word solid, liquid, or gas.

________________



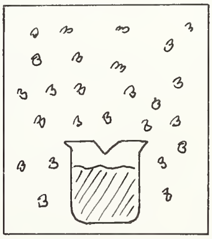
nitrogen

________________



mercury

________________



sulphur

Molecules are always moving.
In a gas molecules are far apart and moving fast.
Molecules are closer together in liquids than they are in gases.
Molecules are very close together in solids. They move very slowly.

Solids, Liquids, and Gases, Worksheet 1

# CLASSIFYING SOLIDS, LIQUIDS, AND GASES

List as many solids, liquids, and gases as you can find in the school.

SOLIDS

| | | |
|---|---|---|
| chalk | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

LIQUIDS

| | | |
|---|---|---|
| milk | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

GASES

| | | |
|---|---|---|
| air | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

# CLASSIFYING SOLIDS, LIQUIDS, AND GASES

Did you include all of the solids, liquids, and gases in the school? Can you name other materials that may be found in your home? Your kitchen cupboard would probably contain some materials which you have not yet named.

SOLIDS- ______________________________

LIQUIDS- ______________________________

GASES- ______________________________

Some materials can be changed from one form or state to another:

a bar of chocolate can become melted chocolate.
a chunk of lead can become molten lead.
a cube of ice can become water.

What must be done to each of the three materials named above to change them from a solid state to a liquid state?

______________________________

Can any of the materials you found and listed be changed from one state to another?

______________________________

How? ______________________________

______________________________

Solids, Liquids, and Gases, Worksheet 2 (continued)

# EVAPORATION

You will need: two dishes of similar size
a medicine dropper
water

- Place the same number of drops of water on each dish. Five drops may do.
- Place one dish in the warmest part of the room.
- This may be near a heat register or in the sunlight.
- Place the other dish in the coolest part of the room.
- Observe each dish before you leave school at the end of the day and again the next morning. Repeat if necessary.

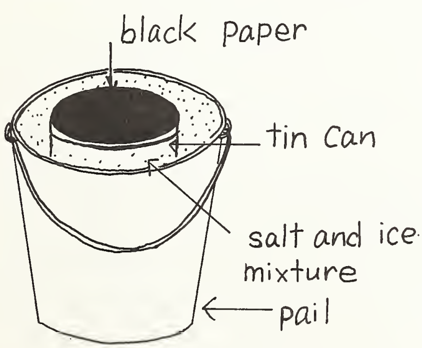
  How long did it take the water to evaporate from each dish?

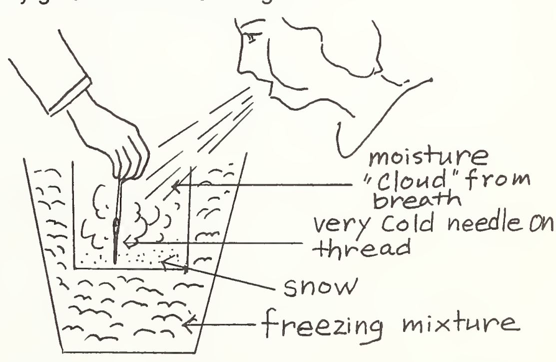
Solids, Liquids, and Gases, Activity Card 5

# MAKING SNOW

You will need: a pail (10 L) or an ice cream freezer
ice and dry ice
a heavy cloth
salt or preferably calcium chloride
a threaded sewing needle
a hammer
a large tin can
black art paper

- Crush the ice by placing it in the heavy cloth and pounding it with a hammer.
- Line the inside of the tin can with black art paper.
- Mix 1 part salt and 3 parts ice and place the mixture around the can in the pail.
- When the can is thoroughly chilled, breathe into it. A cloud of tiny droplets of moisture will form, and will show up against the black background. These droplets are supercooled, which means they are colder than water ordinarily gets without becoming ice.

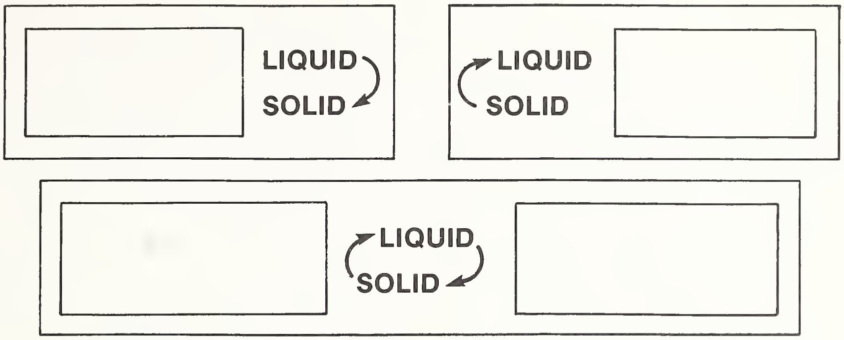



- Lay a threaded sewing needle in the ice and salt mixture. (If you obtained dry ice, lay the needle on a cake of ice to chill it). Move the chilled needle into the can and breath on it. Provided that your needle is very cold, tiny snow flakes should begin to form. The snow flakes are water in its solid state. You have changed water from a gas (your breath) to a solid (snow).

Solids, Liquids, and Gases, Activity Card 6

# HOW MELTING AND FREEZING ARE RELATED



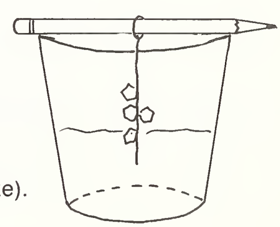

- Cut out each box below and place it on the dotted lines of the drawing above to complete the diagram.
- If you place the statements in the correct place you should see that:

  melting and freezing are a change in state of matter
  freezing is the reverse process of melting

| | | | |
|---|---|---|---|
| **MELTING** **add heat** | **MELTING** **add heat** | **FREEZING** **take away heat** | **FREEZING** **take away heat** |

Solids, Liquids, and Gases, Worksheet 3

# OBSERVING CRYSTAL SHAPES



You will need: boiling water, salt, sugar, alum, epsom salt, borax, food colouring, string, pencils, hand lens, copper sulphate, sodium hyposulphite, water glasses (one for each type of crystal you wish to make).

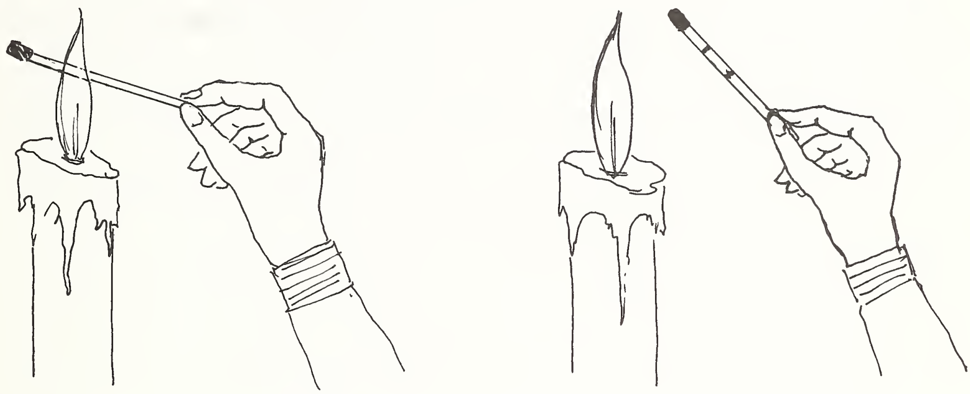
- Use a half a glass of boiling water for each kind of crystal.
- Add some of the powdered alum to the boiling water and stir it until no more will dissolve.
- Tie a string around the centre of a pencil and lay the pencil over the top of the glass so the string hangs in the solution.
- Set the solution aside in a safe place and wait until the next day to observe the string. You should see some diamond-shaped crystals clinging to the string.
- Repeat the above process using salt, sugar, borax, epsom salt, copper sulphate and sodium hyposulphite.
- Use your hand lens. Can you see the differences among the kinds of crystals? Draw what you see.

Solids, Liquids, and Gases, Activity Card 7

# THE HOTTEST PART OF A FLAME

You will need: the candle from “Finding Out” (page 186)
a few matchsticks or similar sticks

- When you light the candle a second time, try holding a burned wooden matchstick sideways in the flame for a moment.
- When you remove the stick, you should see that it is charred only in the two places where the hot outer layer of the flame touched the matchstick.



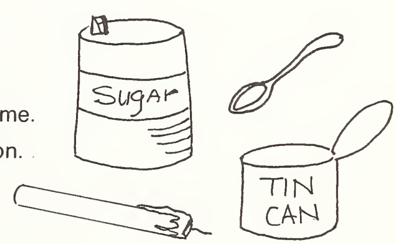
- Test other parts of the flame with other matchsticks to see if you can find out where the flame burns the most.

Can you identify the three states of matter in a burning candle?

Solids, Liquids, and Gases, Activity Card 8

# CHANGING SUGAR

You will need: an old spoon
white sugar
a candle or alcohol burner
a tin can



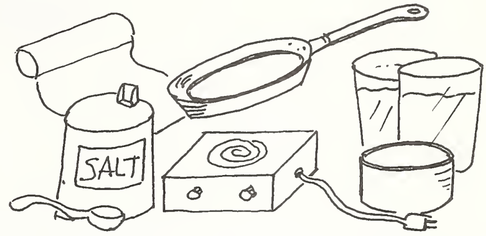

- Place some sugar on the old spoon and hold it over a flame.
- While the sugar is heating, hold the tin can over the spoon.
- Keep heating the sugar until it all changes colour.

What formed in the can?

What did the sugar become?

Solids, Liquids, and Gases, Activity Card 9

# CLEANING SILVERWARE




You will need: some tarnished silverware
a hot plate
an aluminum pan
2 teaspoonfuls of salt
2 teaspoonfuls of baking soda
2 L of water

- Add the water, salt and baking soda to the pan.
- Heat to boiling. Then turn off the heat.
- Place the silverware into the hot solution making sure that all of the silverware is covered by the solution.
- Wait a few minutes. Rinse the silverware under the tap or in plain water, and dry it with a soft cloth.

  What happened to the tarnish?

Solids, Liquids, and Gases, Activity Card 10

# BROWN BOOK (4)
# Unit 5: Air and Weather
**Pages 192-239**

## UNIT OVERVIEW

### Concept Development

In the preceding levels of the program, the following concepts were introduced and developed:

The sun, the air, and water play an important role in weather. There are many different kinds of weather on the earth, and weather in any place changes from season to season. The behaviour of living things changes with each kind of weather.

The sun is an important source of heat and light energy. We measure heat with a thermometer in degrees Celsius. Temperature is something that tells how hot or cold something is. Heat moves through the air by air currents. Warm air rises, while cold air moves down. Water is also constantly moving. It evaporates into the air as water vapour. Water vapour is moved in the atmosphere by air currents. When water vapour cools, it forms clouds and it is changed into rain or snow.

The purpose of this unit is to lead students to an understanding of what makes up air; what causes weather; why weather changes as it does, and how weather may be predicted. The unit develops the concepts that events in the atmosphere can only be interpreted through an understanding of motion, energy, force and change; that these events can be observed, measured and explained; that weather is characterized by interaction and variety, and that the goal of weather forecasting is accuracy in prediction.

Unit 5, "Air and Weather", consists of four chapters. Chapter one discusses the makeup of air, including the concepts that air has weight, takes up space and exerts pressure. Chapter two outlines the ways in which air can change, what causes wind and how clouds are formed. In the third chapter, the concept of weather forecasting is introduced. Instruments used for measuring and predicting the weather are discussed. Types of clouds and how each kind can be an indicator of a weather pattern, are also included in this chapter. Chapter four presents certain weather patterns, such as storms, thunder and lightning, and discusses how these are caused.

### Process Development

In the first part of the unit, students *make inferences* about the properties of air by *observing* classroom *demonstrations* of the properties of air. Students then *infer* and *compare* the amount of heat received in different parts of the world, based on *observations* of *indirect evidence*. The effect of temperature on the ability of air to retain water vapour is then *investigated* by *observing*, *comparing* and *making inferences*.

Students then *design* an instrument that will *measure* air pressure. They *observe* their "instrument" to *measure* and *collect data* on changes in air pressure. By *observing* a classroom *demonstration*, students *infer* that precipitation can remove particles from air by adhering to them.

As a result of these experiences, students should be able to *describe* and *demonstrate* some properties of air and different kinds of weather; *read* weather instruments and *record* weather data; *observe* various kinds of weather; and make *inferences*, *comparisons* and *predictions* from their observations. Students also begin to realize the importance of *systematic observation* in weather *prediction*.

### Related Units

Time (The Seasons) *Orange Book (1)*
Environment (Weather) *Gold Book (2)*
Heat and Temperature *Blue Book (3)*
Water in Your Environment *Blue Book (3)*
Mapping the Earth *Green Book (5)*
Weather—The Changing Atmosphere *Exploring Earth and Space (7)*

### Materials and Advance Planning

The following list includes the materials that a student, or in some cases a group of students, will need to carry out the "Finding Out" activities. In some instances, other materials may be substituted for those on the list.

Cloth, drinking glass, pot of water, 3 balloons, string, metrestick, empty can with screw top (group), hot plate or burner, gloves or mittens, pan of cold water, flashlight, globe of the world, 2 equal sized jars with screw covers, 2 pieces of cloth (6 $cm^2$), needle, thread, wide-mouthed bottle, book, straw, toothpick, piece of cardboard, glue, rubber bands, 2 chalkboard erasers, spray container of water, stopwatch, plastic tubing (50 cm), drinking straws.

If there is a weather station near your school, you may wish to arrange a field trip to it or you may wish to arrange to have the meteorologist visit your class.

## JND INFORMATION

### 'he air around you, pages 194-200

... whole earth and extending outwards from the earth for approximately 800 km is a great mass of air that we call the atmosphere. The atmosphere acts as a protective blanket, shielding the earth from harmful ultra-violet rays and particles and moderating the earth's temperature.

Scientists divide the earth's atmosphere into a number of regions, one on top of the other, each with differences in pressure, temperature, chemical composition and other properties. The region closest to the earth is called the *troposphere*. This is followed by the *stratosphere*, the *mesosphere*, the *ionosphere* and the *exosphere*, respectively. Almost all weather phenomena appear to occur in the lowest level, the troposphere. Other characteristics of the troposphere are: that the temperature falls about 5°C for every 1000 m; that the sky appears blue because the air and dust particles in the troposphere scatter the white light from the sun; and high speed winds, known as the jetstream, occur in the upper part of the troposphere. Recent studies of the atmosphere with rockets and satellites are now supplying new information and data about the earth's atmosphere.

Air is made up of many substances. The two most abundant parts of air are nitrogen and oxygen. Nitrogen makes up about 78% of the air. Nitrogen is an essential element in living tissues. Oxygen makes up approximately 21% of the air. Oxygen is a chemically active gas and is essential for respiration in animals and plants. It is also essential for the combustion of fuels.

Besides oxygen and nitrogen, carbon dioxide is a very important gas found in the air. Green plants need carbon dioxide to make food in a process called photosynthesis. It has other uses such as in baking and in making dry ice.

Water vapour is another gas that has a great influence on living things on earth. The amount of water vapour in the air will vary from 0 to 4 percent of the air. It becomes part of the air when water from the earth's surface evaporates.

The remaining gases account for less than one percent of the air. These include such gases as argon, neon, helium, krypton, xenon, ozone, radon and hydrogen.

Like all matter, air has certain consistent characteristics. Air is colourless, odourless and tasteless. In addition, air has no shape of its own, takes up space and has weight. When heated, air expands and rises; when cooled, air contracts and sinks.

Since air has weight, it presses against things. This pressure is called air pressure. At sea level, air pressure is about 101 kPa. Pressure decreases with height, because the amount of air decreases.

The important concepts to stress in this chapter are that air is essential for life; that air has certain properties; that weather experienced on earth is influenced greatly by the interactions that occur in the atmosphere; and that in order to interpret and predict weather, we have to have an understanding of the atmosphere and its properties.

### Chapter 2: What makes up weather?, pages 201-211

There are four major conditions of the air that play a part in the earth's weather. These conditions—temperature, pressure, wind and moisture—are constantly changing. These conditions are caused by the energy, force, motion and change effected by the sun, the air and water.

*Radiant energy* from the sun is the primary cause of all weather phenomena. When radiant energy strikes the earth's surface, it is changed into heat energy. However, the amount of heat energy received and absorbed by the earth's surface, will vary from place to place and from time to time. Some of the reasons for these variations are:

— the fact that the earth is round means that different parts of the earth receive radiant energy at different angles. Thus areas near the equator that receive radiant energy more directly, will receive more heat than areas further away from the equator that receive slanting rays.
— the amount of heat energy absorbed depends on the kind of surface being heated. Water heats up and loses heat energy much more slowly than land.
— the tilted axis of the earth and the revolution of the earth around the sun, causes variations in the amount of heat received by any place at different times of the year.

In addition to affecting temperature, radiant energy is involved in the production of wind. The uneven heating of the earth results in the uneven heating of the air above it. When the air close to the earth's surface is heated, the air expands and becomes lighter than an equal volume of cold air. The warm air rises as an upward air current, and is replaced at the earth's surface by cooler, heavier air that is moving laterally. This movement of air, which is called *convection*, produces winds. Convection winds can be on a local or global scale.

Because air has weight, it presses down on the earth's surface, causing *air pressure*. Differences in air temperature may result in the formation of areas of high pressure and regions of low pressure. Air usually moves from a high pressure area to a low pressure area. This movement of air produces what are called *fronts*. When cold air pushes against warm air, the front is called a cold front. When warm air pushes against cold air, the front is called a warm front.

Water is another important cause of weather phenomena. Due to heat energy, water is in constant circula-

tion. Water evaporates from the earth and the water molecules mix with the other components of the air as *water vapour*. The term used to state the amount of water vapour in the air is *humidity*. As water vapour forms, it rises and cools. When the air contains as much water vapour as it can hold at a given temperature, it becomes *saturated*, and the water vapour forms clouds. The water droplets in a cloud may merge to form heavier droplets that fall back to the earth as *precipitation*. This endless cycle of evaporation and condensation is called the *water cycle*.

The important concepts to stress in this chapter are that weather is caused by the interactions that occur in the atmosphere. These interactions are greatly influenced by the functions of radiant energy, air and water.

### Chapter 3: What's the weather going to be like? pages 212-224

*Weather* may be defined as the condition of the atmosphere at a given time and at a particular place. A person who studies and forecasts weather is called a *meteorologist*. In forecasting weather, meteorologists collect data on such things as temperature, humidity, wind direction and speed, air pressure and sky condition. Meteorologists collect this information from many points of the earth, from the atmosphere and from satellites. To collect the data, a meteorologist uses a variety of weather instruments.

Several different kinds of *thermometers* may be used. Sometimes metal thermometers are used and other times thermographs, or self-recording thermometers, are used to determine the temperature. The scale used to measure temperature is the Celsius scale. Temperature readings at the earth's surface are made in an enclosure open to the air; but shaded from the sun. Knowing the air temperature at different elevations above the earth is important in forecasting.

To determine the relative humidity, meteorologists use an instrument called a *hygrometer*. A hygrometer may be the wet-and-dry-bulb type or the human hair type. Both types are effective in determining the actual amount of water vapour in the air. Relative humidity is expressed as a percentage. If the relative humidity is fifty percent, for example, it means that the air is holding only half the amount of water vapour that it could.

Collecting data about wind requires two measurements—its direction and its speed. The *weather vane* measures wind direction. Winds are named by the direction from which they come. A westerly wind, for example, blows from the west. Data about wind speed is collected by an instrument called an *anemometer*. Weather stations generally use an instrument called an *aerovane*, which is a combination anemometer/ weather vane.

Rainfall is collected in an instrument called a *rain gauge*. A rain gauge catches rain in a funnel that is ten times as large as the opening of the collecting jar. This magnifies the reading ten times. Snowfall is measured by placing a stick into the snow in an open location. Weather stations often use a gauge that weighs the amount of precipitation (rain or snow). This weight is automatically translated into a precipitation amount.

Two types of *barometers* are used to measure air pressure. One is called the mercury barometer. The mercury barometer is a narrow glass tube about 90 cm long. A scale is marked on the glass tube. The barometer is sealed at one end, and the open end is placed in a cup of mercury. At sea level, normal air pressure will push the mercury up to a reading of 101.325 kPa.

An aneroid barometer (meaning without liquid) may be used. This type of barometer is made up of an airtight box, from which most of the air has been removed, and a dial with a pointer. As the atmospheric pressure increases, the metal sides of the box are pushed in. As the atmospheric pressure decreases, the sides of the box expand. These changes in the sides of the metal box control the position of the pointer on the dial.

The meteorologist does not only rely on weather data collected at the surface of the earth. Modern technology gives the meteorologist information about weather conditions at different levels as well as over greater areas of the earth's surface. *Radar* is one such instrument. Radar can detect the presence of atmospheric disturbances hundreds of kilometres away. Their paths and speed can also be predicted. The *radiosonde* is an unmanned balloon that has a package of instruments on it. Measurements are converted into radio signals that are broadcast back to earth. The radiosonde's range is about 32 km. Weather rockets supply weather data above 32 km. *Weather satellites* provide weather data for the entire globe at different levels of the atmosphere.

Observing the kinds of clouds in the sky also provides meteorologists with information about the weather. Generally speaking, the names given to clouds are indicative of their appearance or of the weather conditions resulting from them. For example, *stratus* clouds are layerlike and appear as a thick blanket of low level clouds. Stratus clouds often produce a drizzle-type rainfall. *Cumulus* clouds are masses of white, fluffy clouds that are usually seen near the surface of the earth. Meteorologists know that cumulus clouds seldom produce precipitation. Therefore, on days when cumulus clouds are observed, meteorologists usually predict that the weather will be fair and warm. *Nimbus* clouds are dark, gray clouds that produce rain or snow. *Cirrus* clouds are white, curly clouds that are very high. Often their appearance means that rain or snow is on its way.

Improvements in weather forecasting have resulted from the development and refinement in the methods of measuring and transmitting weather data. The speed at which this data is supplied and the global nature of meteorology have resulted in further improvements. At

present, research is being carried out in the area of weather modification and weather control. One such control people have developed is cloud seeding. This is a technique used to produce rain at a given place. Cloud seeding usually is done by dropping particles of dry ice, silver iodide, or other crystals into clouds. These particles or crystals cause tiny droplets of water in the clouds to collect around the particles and to change into ice crystals. These ice crystals grow larger as the water vapour in the clouds condenses on the crystals. When the crystals become large enough, they fall as snow or as rain, depending on the temperature of the air.

The concepts that you may wish to stress in this chapter are that weather is characterized by interaction and variety, and that systematic and accurate observation of these interactions are needed for accurate predictions in weather forecasting.

### Chapter 4: Stormy skies, pages 225-235

Many of the storms experienced on earth are related to high and low pressure areas. High pressure areas, or highs, have the highest air pressures at their centres, and winds blow outwards and descend in a clockwise direction in the Northern Hemisphere. (In the Southern Hemisphere the winds blow in the opposite direction). Low pressure areas, or lows, have the lowest air pressures at their centres, and winds blow inwards and ascend in counter-clockwise direction in the Northern Hemisphere. Highs are generally associated with good weather, whereas lows often bring stormy weather.

The smallest, most violent and most short-lived storm is a *tornado*. Most tornadoes move in a path from the south-southwest to the north-northeast, in the Northern Hemisphere. Their average speed is about 50 km per hour. The winds that make up a tornado rotate counter-clockwise and can reach a speed of about 800 km/h. This rapidly rotating wind, and the debris that is forced into the tornado, make the tornado look like a spinning top. Tornadoes generally cover a small area, averaging about 400 m in diameter. The movement of a funnel-shaped cloud is extremely erratic. That is, the cloud may touch down for only a few seconds, skip over a small area, and then touch down again. It is for this reason that the path of the funnel-shaped cloud cannot be determined beforehand.

Another kind of storm that has strong winds and that can cause great damage is a *hurricane*. Hurricanes occur in various parts of the world. They always form over oceans. Most hurricanes form within 12 degrees of the equator in the period between June and November. Heat energy from the sun warms the tropical waters and the air above them. The water evaporates and in the process stores much heat energy. When the water vapour condenses, this heat energy is released causing the characteristic, strong winds.

A hurricane may be about 480 km in diameter. In the centre of a hurricane, there is a calm area called the eye. The eye often is about 25 km in diameter. Within the eye the sun often shines, the sky is clear and there is little wind. Wind speed outside the eye, however, may reach about 240 km an hour.

Unlike the paths of tornadoes, the paths of hurricanes can usually be predicted. As a hurricane develops, it moves westward and away from the equator until the hurricane reaches temperate latitudes. Because of a force called the Coriolis force, which results from the earth's rotation, the hurricane is then deflected to the east. Because their paths can be predicted, people usually have time to move away from the path of a hurricane.

Another kind of storm is the *thunderstorm*. Extreme turbulence, high winds, heavy rain, lightning, and sometimes hail characterize thunderstorms. A thunderstorm has three stages: (1) the cumulus stage, (2) the mature stage and (3) the dissipating stage.

Generally speaking, cumulus clouds do not contain a great deal of water vapour. However, as the cumulus clouds pass over bodies of water, the clouds often take on a great deal of water vapour due to evaporation. As the cumulus clouds reach their saturation point, they change into what is called *cumulonimbus clouds*. Cumulonimbus clouds are fluffy, dark-gray rain clouds. Severe updrafts and downdrafts are common in cumulonimbus clouds, resulting in extreme air turbulence.

When cumulonimbus clouds reach their saturation point, rain begins to fall. At this point, the thunderstorm has reached its mature stage. The clouds then pass out of the area, and the thunderstorm reaches its dissipating stage.

Thunderstorms may be multicelled or single celled. A multicelled thunderstorm is one in which certain cells, or parts, of the thunderstorm are in different stages of development. Therefore, a multicelled thunderstorm often lasts for a period of hours. A single-celled thunderstorm usually lasts only as long as it takes the single cell to pass through the three stages of development. That length of time is usually little more than an hour.

Lightning often occurs during certain storms as a result of fast-moving air currents within clouds "rubbing" against one another. The "rubbing" action of the air currents produces static electricity in the same way that people sometimes produce static electricity when walking across a rug. A flash of lightning occurs because of electric charges built up in the clouds. Some of these charges are positive and others are negative. A flash of lightning ocurs when the charges from one cloud jump to another cloud that is carrying an opposite charge. Sometimes, the flash of lightning touches the earth. When that occurs, it is because the area of the earth struck is carrying electric charges opposite to those carried by the cloud from which the charges jumped.

Flashes of lightning between clouds and the earth have been measured up to lengths of about 13 km.

Radar has revealed that a flash of lightning between clouds can measure 160 km or more. In one flash of lightning, the electricity may exceed 15 million volts.

The thunder, which accompanies lightning, occurs because the air through which the flash of lightning travels is quickly heated, resulting in a rapid expansion of the air. Because the expansion of air takes place extremely fast, the expanding air "smashes" against the surrounding cooler air, causing the sound known as thunder.

The distance a flash of lightning is from a person can roughly be determined by timing the thunder produced by that flash. Light travels faster than sound; therefore, a flash of lightning will always be seen before the thunder is heard. The distance between a flash of lightning and a person can be determined in the following way: Thunder travels about 1.6 km every five seconds. Therefore, if a person sees a flash of lightning and then hears the thunder ten seconds later, the approximate distance of the lightning would be 3.2 km.

A rainbow can be seen only when it is raining, or just after a rain, and when the sun is shining from behind a person. The raindrops act as prisms, breaking up the sun's light rays and reflecting parts of the light rays toward the earth's surface. It is the reflection of parts of the sun's light rays that produces the many colours seen in a rainbow.

## TEACHING STRATEGIES

The purpose of the following activities and teaching strategies is to provide you, the teacher, with a wide variety of suggestions that can be used together with the material presented in the textbook to develop the processes and concepts of this unit.

### Introduction

- **Viewing Centre.** There are many filmstrips and media kits available that can be used to reinforce the concepts in this unit. You may wish to set up a filmstrip centre for this unit. Activity Cards 1.1-1.3 could be used at the viewing centre.
- **Air and Weather Dictionary.** You may wish to have students key words with their meanings (as understood by the student) as they progress through the unit. At the end of the unit, reinforce their understandings of key words by having a "word-guess" game. Students read their definitions, and see who can identify the key word.
- Following a discussion of the cartoon on page 193, you may wish to have a "Paper Airplane Contest".

  Develop with your class a list of *categories* that will be used to judge the planes. Some examples of categories are: the highest flight, the farthest flight, the fastest flight, the smoothest landing, the best looking, the most original.

  Ask your students to list the things (*variables*) that they need to consider about air before they design their planes. Have the students design their paper airplanes and hold the Paper Airplane Contest. After the contest, have a class discussion about what they have learned about air from this activity.

### Chapter 1: The air around you, pages 194-200

#### Air takes up space

- Do the "Finding Out" on page 195 to show that air occupies space.
- You may wish to reinforce this concept by doing Worksheet 1, "Air Obstacle Race."

#### "Finding Out" (page 197)
#### How can you show that air has weight?

- You may wish to have your students complete Activity 29 in their Activity Books (Textbook page 197).

*Processes used and sample findings:*

- *Observation Skills.* Students will *observe* that as the air escapes from the balloon, the balloon becomes smaller. They will also observe that the metre stick begins to tip and lose its balance.
- *Inference Skills.* From their observations students will *infer* that the balloon with the leaking air will rise because the mass of the other balloon with the air still inside it will be greater.
- *Prediction Skills.* You may wish to ask your students to think of other ways they could show that air has weight. Students could *predict*, for example, that weighing an inflated and deflated basketball will also show that air has weight.
- *Experimentation Skills.* You may wish to have your students test their predictions by designing and carrying out experiments.

#### "Finding Out" (page 199)
#### How can you show that air has pressure?

- **NOTE:** You may wish to carry out this activity as a classroom demonstration, or as a small group activity, *because it is an activity that requires close teacher supervision.*

*Processes used and sample findings:*

- *Observation Skills.* Students will *observe* that when the can is placed in a pan of cold water, it collapses. As it collapses, the students will hear the sound of bending metal.
- *Inference Skills.* From their observations, students will *infer* that the can collapsed because the air pressure outside the can is greater than the air pressure inside the can. When the water was heated and the steam flowed out of the can, most of the air was pushed out. The top was screwed on, not allowing any air into the can. The cold water caused the steam inside the can to drop. This forced in the sides of the can.

#### Problem Solving: Activity Cards 2.1-2.4

- You may wish to have your students carry out some

additional activities based on the properties of air. For each activity ask students to:
— make a prediction or state a hypothesis
— design a procedure
— test their ideas by carrying out the investigation
— collect data
— describe their findings in writing, with data, or by means of diagrams.

### Chapter 2: What makes up weather?, pages 201-203

### How warm or how cool? (pages 202-203)

— The information on pages 202 and 203 can be read and discussed.
— You may wish to have students carry out the "Exploring on Your Own" (page 203).
— If you have access to a number of thermometers, you may wish to have students *record* temperatures in and around the school.

### "Finding Out" (page 204)
### How can you show why some places on earth get more of the sun's heat than other places?

— You may wish to have your students complete Activity 31 in their Activity Books (Textbook page 204).
— NOTE: You may wish to review the concept of an *angle* with your students before this investigation. If they do not have a good understanding of the concepts of *directly* and *at an angle*, they may have difficulty with this investigation.

*Processes used and sample findings:*
— *Observation and Comparison Skills.* Students will *observe* that the flashlight or "sun" shining directly on the globe, lights up a smaller area and illuminates the area more brightly than the flashlight or "sun" shining at an angle on the globe. As the angle is increased, the area illuminated on the globe increases, and the intensity of the light decreases.

You may wish to have your students quantify these observations in some way. They could use string to *measure* the size of the area that is illuminated. They could develop a standard of measure for the light intensity, such as the ease of reading place names on the globe.
— *Inference Skills.* From their *observations* and *comparisons* students will *infer* that the place on the globe receiving direct sunlight will get more heat because the light energy is more concentrated on this place.

### The wet part of the weather (pages 207-209)

— After students have studied the water cycle on pages 207 to 209, you may wish to have them describe the series of events that occur in the water cycle and make a drawing to illustrate the explanation.

### "Finding Out" (page 210)
### Which holds more water vapour, warm air or cold air?

— You may wish to have your students complete Activity 32 in their Activity Books (Textbook page 210).

*Processes used and sample findings:*
— *Observation and Comparison Skills.* Students will *observe* that after one hour, the cloth that is in the cold jar in the refrigerator is wetter than the cloth in the warm jar.
— *Inference Skills.* From their observations and comparisons, students will *infer* that water evaporates more quickly in the warm jar and that warm air holds more water vapour than cold air.

### Senses Chart

— Activities using the senses, help students develop the vocabulary needed to describe a concept or an experience.
— Ask your students to go out at different times of the day and different times of the year to *describe* the characteristics of wind, rain, snow, and sun, using their senses.
— You may wish to use Activity Card 3 for this activity.

### Creative Writing and Poetry.

— You may wish to use the sun, wind and rain as a theme for some creative writing and poetry. Here are some suggestions:
— 1. Short Story: Pretend that you are a drop of water. Write a story about your adventures as you go through the water cycle.
— 2. A Myth. Go outside on a windy day. Listen, watch and feel the wind for a few minutes. Close your eyes and imagine that you are in a dense forest with the wind whistling through the trees. It is the year 500 A.D. Use your imagination to write a myth about the power of the wind.
— 3. Haiku Poetry: Japanese poets have used a special form of poetry for hundreds of years, to describe scenes from nature. The form of poetry is called haiku. It is an unrhymed poetry form, composed of seventeen syllables, expressing a thought in three lines.

Line 1 tells what the subject is (in 5 syllables)
Line 2 tells where the subject is (in 7 syllables)
Line 3 tells how or what the subject is doing (in 5 syllables)

Ask the students to go outside and experience the wind, sun, rain or snow for about ten minutes. As they experience these elements, ask them to let words flow freely through their minds. After ten minutes, ask

them to use some of their feelings and thoughts to write a haiku poem.

Quiet royalty
billowing free and easy
Clouds puff in the sky.

### Research

— The sun, wind and rain played an important part in many cultures and civilizations. You may wish to have your students *research* civilizations that worshipped gods or goddesses of the sun, rain or wind.

## Chapter 3: What's the weather going to be like?, pages 212-224

### Weather forecasting.

— Before beginning this chapter, you may wish to have your students go outside and *observe* the weather for a few minutes. Repeat this on a few occasions when the weather conditions are different.
— Each time the students observe the weather, ask them to list all the things that they think are important to know in order to be able to *predict* the weather for the following day.
— Use these observations and lists in a class discussion to introduce this chapter.
— The information on pages 212 and 213 can be read and discussed.

### Weather instruments (pages 215-220)

— Read and discuss the different weather instruments described on pages 215-220.
— If you have access to simple weather instruments, *demonstrate* how each one works.
— Set up stations for each weather instrument and have students practise reading and handling them.

### Making weather instruments

— You may wish to have groups of students *design* some simple weather instruments.
— There are many good references for constructing simple weather instruments such as rain gauges, wind vanes, wind socks, anemometers, hygrometers and barometers.
— You may wish to have students *research* different designs in the library, before they construct their instruments.

### "Finding Out" (page 220)
### How can you "see" changes in air pressure?

— You may wish to have your students complete Activity 33 in their Activity Books (Textbook page 220).

*Processes used and sample findings:*

— *Observation and Comparison Skills.* Students will *observe* that on the days when the readings were high, the weather was most likely clear or cool. On the days when the readings were low, the weather was most likely warm or cloudy.
— *Measurement Skills.* Students construct the scale by recording the position of the toothpick on the cardboard for a week, and they record the air pressure reading, obtained from a weather report, on the cardboard.
— *Collecting Data.* Students *collect data* on the barometer reading and the weather conditions for one week, and they record their data on a chart.

| DAY OF WEEK | WEATHER CONDITIONS | BAROMETER READING |
|---|---|---|
| | | |

—*Inference Skills.* From their observations and data, students will *infer* that changes in air pressure are related to changes in weather conditions. If the barometer readings rise, for example, students may infer that the weather will be clear or cool.

### Clouds

—After studying pages 221-223, you may wish to have your students do one or more of these activities:

— 1. Cloud watchers: Have your students go outside, lie down or sit down in a quiet, open space, and watch the clouds.

Ask them to *identify* the cloud types from what they have learned about clouds.

Ask them to list words that describe each cloud type. They may wish to use words that describe properties such as *texture, form, shape, height* and *speed of movement.*

Ask them to describe pictures of animals or plants, or other things that they can see in the cloud formations. They may wish to use these cloud "pictures" to think of ideas for a short story.

— 2. Cloud diorama: Students could depict the cloud formations and the properties of each cloud type in a shoe box, using absorbent cotton. They could cut out a scene from cardboard and paste it on the bottom of the shoebox. The diorama could be viewed through a peephole at the end of the box, and the amount of light entering the box could be controlled by an opening on top of the box, that is covered with a cardboard flap.

### High/Low Map

—After completing Chapter 3, you may wish to have your students locate the highest and lowest *values* of a number of environmental factors.

—On a sketchmap of the school grounds, have them *record*: the windiest and calmest; hottest and coldest; sunniest and shadiest and wettest and driest places.

—Ask them to do this first by using their senses and then by using weather instruments.

### Weather Station

—You may wish to set up a weather station on the school grounds. Students could take turns *reading the instruments* and *collecting data.* They could also use the data to make a weather forecast for the day. The data could be *recorded* on a class chart on a monthly basis.

—Worksheet 2 could be used to record the data.

—If weather instruments are not available, you may wish to have students use Worksheet 8 to record daily weather conditions.

—You may wish to use Worksheet 3 as a record sheet for the "Suggested Activity" on page 223 of the Teacher's Edition.

### Weather Proverbs

—You may wish to have your students make a *collection* of weather sayings and proverbs, by asking adult relatives and friends.

—Have your students *classify* these proverbs according to the type of weather they *predict.* You may wish them to do this classification on a class chart. Ask your students to *investigate* the accuracy of these proverbs by using them to forecast the weather.

—Page 239 of the textbook lists some proverbs. Here are some additional examples:

When the dew is on the grass
Rain will never come to pass.

When teeth and bones and bunions ache
Expect the clouds to fill the lake.

When grass is dry at morning's light,
Look for rain before the night.

A red sky has water in its eye.

Welcome the sound of crackling hair
It tells of weather clear and fair.

Flies and mosquitoes are biting and humming
The swallows fly low; A rainstorm is coming

Red sky in the morning,
  Sailors take warning.
Red sky at night,
  Sailors delight.

When high clouds and low clouds
  do not march together
Prepare for a blow and a change
  in the weather.

Sounds travelling far and wide,
A stormy day will betide.

## Chapter 4: Stormy skies, pages 225-235

### Research Cards

—You may wish to use this chapter to develop the research skills of your students. Activity Cards 4.1 to 4.5 could be used.

—Ask your students to select an activity card. They may add more questions to the activity card.

—They then use the questions to *develop a topical*

*outline* for their report; they *collect information on data*, and *write the report*.

**"Finding Out" (page 226)**
**Does rain help clean the air?**

— You may wish to have your students complete Activity 34 in their Activity Books (Textbook page 226).

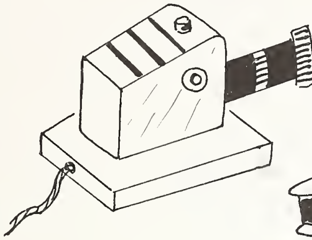
*Processes used and sample findings:*

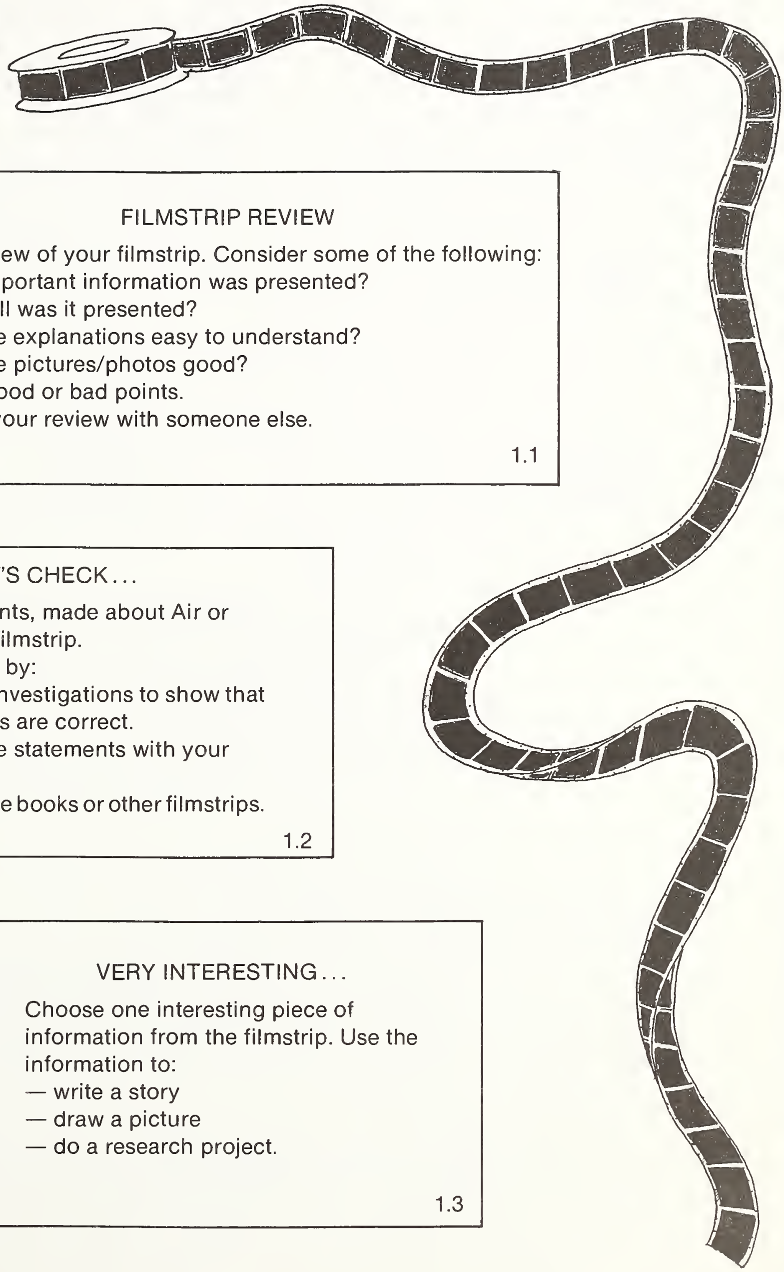
— *Observation Skills.* Students will *observe* that when water is sprayed on the chalk dust, the air clears.

— *Inference Skills.* From these observations students will *infer* that the chalk dust particles stick to the water. The chalk dust and water are heavier than the air and they fall to the floor, thus clearing the air of the chalk dust.

Students will infer that during a rainstorm, the raindrops may remove dust, smoke and pollen from the air.

# VIEWING CENTRE





### FILMSTRIP REVIEW

Write a review of your filmstrip. Consider some of the following:
— What important information was presented?
— How well was it presented?
— Were the explanations easy to understand?
— Were the pictures/photos good?
— Other good or bad points.
Compare your review with someone else.

1.1

### LET'S CHECK...

List two statements, made about Air or Weather on the filmstrip.
Check these out by:
— carrying out investigations to show that the statements are correct.
— discussing the statements with your friends.
— using reference books or other filmstrips.

1.2

### VERY INTERESTING...

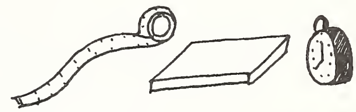
Choose one interesting piece of information from the filmstrip. Use the information to:
— write a story
— draw a picture
— do a research project.

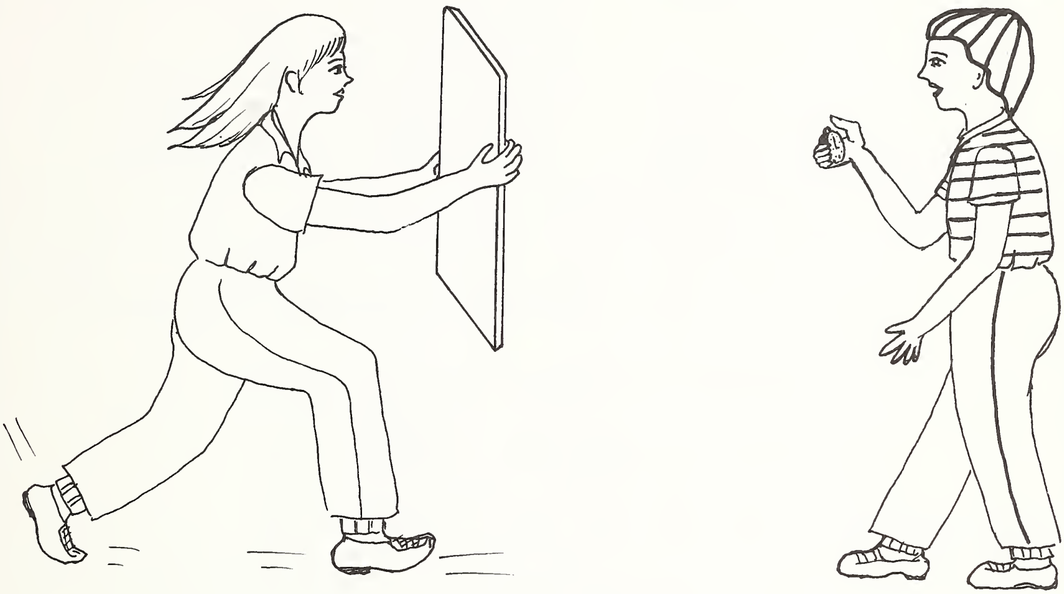
1.3

Air and Weather: Activity Cards 1-1 to 1-3

# AIR OBSTACLE RACE

You will need: a metrestick
a 1 m by 50 cm piece of cardboard
a stop watch
a partner





How to proceed:

- Measure off a 50 m racetrack on the playground.
- Have your partner stand at the finishing line with a stopwatch.
- Go to the starting line. Hold the cardboard in front of you.
- Have your partner time how long it takes you to run 50 m with the cardboard in front of you.
- Now have your partner time how long it takes you to run 50 m without the cardboard.
- Change roles. Time your partner's two runs.

Record Sheet:

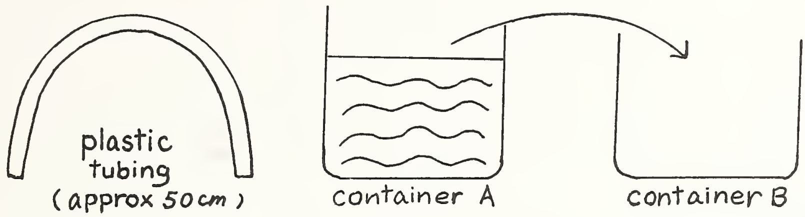
| | ME | MY PARTNER |
|---|---|---|
| 1. Time with the cardboard | | |
| 2. Time without the cardboard | | |

For Discussion:

Discuss the results of this activity with your partner and with your teacher.

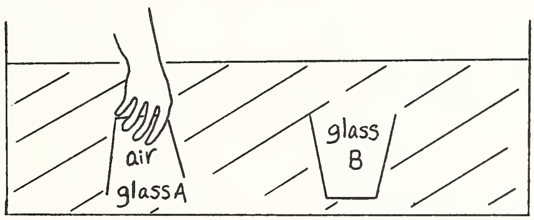
# PROBLEM SOLVING

Problem:
Can you transfer water from container A to container B using the plastic tubing?




Air and Weather 2.1

Problem:
Find a way to pour air from glass A into glass B.

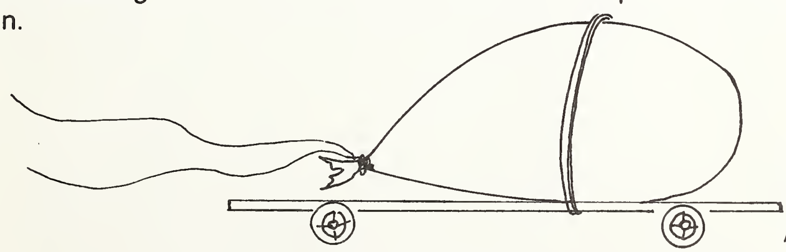



Air and Weather 2.2

Problem:
How does sucking juice through a straw work?

Air and Weather 2.3

Problem:
Design something that can make use of the air that escapes from a blown up balloon.



Air and Weather 2.4

Air and Weather, Activity Cards 2.1-2.4.

## SENSES CHART

- Use your senses to describe wind, sun, rain, and snow.

| | SEE | HEAR | TOUCH/FEEL | SMELL/TASTE |
|---|---|---|---|---|
| WIND | | | | |
| SUN | | | | |
| RAIN | | | | |
| SNOW | | | | |

# DAILY WEATHER RECORD

DATE BEGUN: ____________________ DATE ENDED: ____________________

| DATE | TEMP. °C | AIR PRESSURE | WIND SPEED & DIRECTION | SUN & CLOUDS | CLOUD TYPE | PRECIPIT. RAIN & SNOW | MY FORECAST | ACTUAL WEATHER |
|---|---|---|---|---|---|---|---|---|
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**KEY**

| | | |
|---|---|---|
| clear | Calm | Cu Cumulus Cloud |
| partly cloudy | Light breeze | Ci Cirrus Cloud |
| mostly cloudy | Windy | Ni Nimbus Cloud |
| overcast | Very Windy | Str Stratus Cloud |

NW N NE
W E
SW S SE

# Weather Record for ____________________

| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|---|
| | | | | | | |
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Weather

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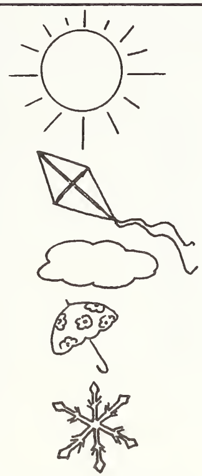
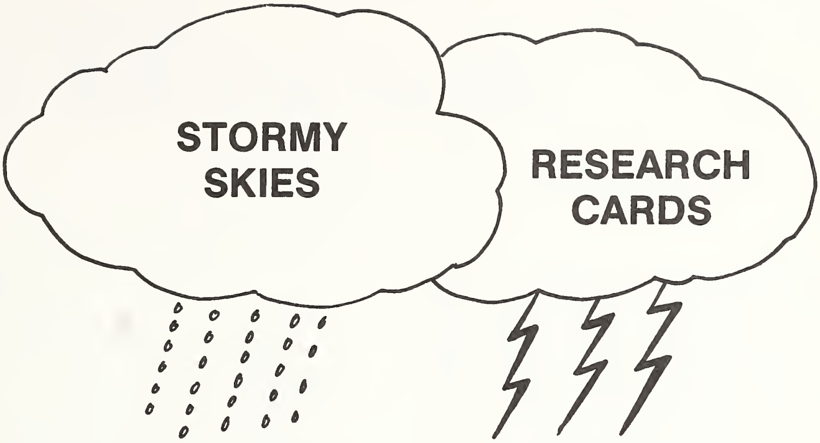
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Number of Days | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |




RAINBOWS

1. When do we see rainbows?
2. What causes rainbows?
3. What are the colours in a rainbow?

4.1

TORNADOES

1. What is a tornado?
2. When do tornadoes occur?
3. Some examples of tornadoes.

4.2

THUNDER AND LIGHTNING

1. When do we hear thunder?
2. When do we see lightning?
3. How are thunder and lightning related?
4. What are some uses and dangers of lightning and thunder?

4.3

HURRICANES

1. What causes hurricanes?
2. How are they different from tornadoes?
3. What are some examples of hurricanes?

4.4

TIDAL WAVES

1. What are tidal waves?
2. How are they formed?

4.5

Air and Weather, Activity Cards 4-1 to 4-5

# BROWN BOOK (4)
# Unit 6: Watching the Sky
**Pages 240-281**

## UNIT OVERVIEW

### Concept Development

In the preceding levels of the program, students were introduced to the concepts of distance, direction and position in space and time. They also considered the moon, its nature and its relationship to the earth.

Children's interest in space-related material is generally high. They are exposed to many ideas about space and space exploration through television, films and books. This interest is further highlighted by the increasing impact that space science is having on how people live and communicate with each other.

In attempting to help students understand concepts about space, it is important, wherever possible, to relate the concepts to activities, models, analogies and frames of reference that are within their experience. It should also be stressed that we learn about objects and events in space by observing and collecting data about changes in form, position, colour, temperature and phase. As the data we collect about space becomes more detailed and more accurate, our view and understanding of space changes.

Unit 6, "Watching the Sky", consists of four chapters. Chapter one provides information about stars, including what they are, why they "twinkle" and why they are different in colour. Also included is information about why stars seem to move and the names and shapes of some common constellations. Chapter two discusses the sun, with emphasis on its importance to living things on earth. Such topics as how planets differ from stars and how planets differ from one another are discussed in the third chapter. Also included in chapter three is information on what causes day and night and what causes the seasons. Chapter four describes certain characteristics of the moon. This chapter also explains why the moon seems to change shape and why it periodically eclipses the sun.

### Process Development

Students begin the unit by setting up *experimental models* to *demonstrate* why stars are only seen at night (page 244) and why stars seem to twinkle (page 245). They use their *observations* in these "Finding Outs" to make *inferences* about stars.

Students then construct a simple telescope (page 250). By *comparing* what they see with and without the telescope they make *generalizations* about the importance of telescopes in the science of astronomy.

In the "Finding Out" on page 252, students simulate stars with flashlights. They *observe* that closer "stars" seem brighter, and *infer* that the sun's closeness to the earth is why the sun seems brighter than other stars. Students then *construct* a sundial (page 256) and by *observing* the sundial's shadow, they *infer* that the length and position of the shadow is affected by the position of the sun.

How planets travel in orbit around the sun (page 260), causes of day and night (page 263), and causes for the earth's seasons (page 265), are then demonstrated through *experimental models*.

The unit ends with students simulating an eclipse (page 276) and demonstrating why we only see one side of the moon from the earth (page 277).

### Related Units

Light and Shadows *Orange Book (1)*
Time *Orange Book (1)*
The Moon *Gold Book (2)*
Location, Motion and Force *Blue Book (3)*
The Earth in Space *Red Book (6)*
Universe: Exploring Environments in Space *Exploring Earth and Space (7)*

### Materials and Advance Planning

The following list includes the materials that a student, or in some cases a group of students, need to carry out the activities in this unit. In some instances, other materials may be substituted for those on the list.

Table, 2 flashlights of the same brightness, bright lamp, extension cord, dark room, dark paper, magnifying glass, source of heat such as a hot plate or a radiator, 2 magnifying glasses (just the lenses), thin cardboard, scissors, tape, nail, glue, clock, string, small rubber ball, globe of the earth, small piece of paper, tennis ball, room with an empty space.

The additional activities suggested in the Resource Guide require: Empty paper roll, cardboard, ice cubes, 3 saucers, 6 bean seeds, 3 plastic containers, thermometer, plasticine, 4 nails, light source, empty cardboard carton, sandy soil, rocks of assorted sizes.

## BACKGROUND INFORMATION

### Chapter 1: A sky full of stars, pages 242-250

Since ancient times, people have watched the sky. Early farmers looked for certain stars to help determine

planting times. Seafarers navigated by means of the stars. Storytellers originated myths about sky animals and kings that persist to this day.

At one time, people thought that stars were little lights strewn in the sky. Today, however, people know that stars are huge bodies of incredibly hot gases located far beyond the earth. Except for the sun, which is also a star, the closest star to the earth is over four light-years away. In other words, it would take light travelling from that star at approximately 299,800 km/s four years to reach the earth.

Of all the stars visible to people, the smallest stars are thought to be about the size of the earth. The sun is considered to be an average-sized star. The largest stars are thought to be about 500 times larger than the sun.

In order for a star to be observed by someone on the earth, the light from that star must pass through the air of the earth's atmosphere. This air is in constant motion. Therefore, as light passes through the moving air, the light is constantly bent in different directions. This constant bending of the light is what causes stars to seem to twinkle.

If you observe stars on a clear evening—away from city lights—the stars may seem different in colour. Some may appear to be red, orange or yellow. Other stars may appear to be yellow-white, white or blue-white.

The colour a star gives off depends on the kinds of gases making up the star. For example, some gases burn at a low temperature causing the star to appear red in colour. Other gases burn at a high temperature causing the star to appear blue-white in colour.

The sun's temperature is in the middle range. If the sun's temperature were not, the earth would be too hot or too cold to support existing life.

When viewed from the earth, the sun and the stars appear to be moving in space. That is, the sun seems to rise, move across the sky, and set. Most stars also seem to move in this way. Of course, stars that appear above the earth's axis of rotation, such as the North Star, seem to have little or no apparent motion. However, because the sun and the stars are so far away from the earth, they are almost fixed in space. The apparent motion of the sun and the stars is caused by the earth's rotation.

A constellation is a group of stars that appear to belong together because of some easily perceived shape. Ancient observers named constellations after numerous objects, animals and people.

The stars making up a constellation often appear to be an equal distance from the earth. This is because the stars are so far away that people can see the stars from only one angle.

If people could observe the stars in a constellation from a different angle, however, they might find that the stars making up most of the constellations are not an equal distance from the earth and that most constellations would be extremely difficult to point out.

### Chapter 2: A special star, pages 251-256

People usually do not think of the sun as a star. This is because its closeness to the earth gives the sun an appearance different from that of other stars. The sun is about 150 million km from the earth, whereas the next closest star to the earth is approximately four light-years away.

Although the sun is only average in size when compared with other stars, the sun's diameter is about 109 times larger than the diameter of the earth. If the sun were hollow, a million earths could fit inside it.

The sun is extremely important for many reasons. One reason is that the sun is the major source of energy for the earth. The energy given off by the sun is called solar energy, or radiant energy. Very little of the sun's total energy reaches the earth. However, the solar energy that does reach the earth produces a sufficient amount of heat energy to support life.

The use of solar energy to heat homes and other buildings may become a popular alternative to the use of fossel fuels. For this reason different methods of capturing solar energy have been and are being developed.

In one common method, a flat metal plate is fastened to a pitched roof that faces south for maximum sunlight. Mounted to the plate are water pipes. Both the plate and the pipes are painted black to absorb as much solar energy as possible. A glass cover over the plate keeps heat from escaping. Water flows through the pipes, becomes heated by sunlight, and then is stored in a large tank. The heated water may then be piped throughout a building, thus heating the building.

Solar energy may also be used to generate electricity. In one setup, a solar battery is used. The battery contains many plates composed of silicon, a common element found in the earth's crust. When sunlight strikes the plates, an electric current is produced. Certain problems must still be resolved before the use of solar batteries becomes practical. Those problems include the high cost of solar batteries and the difficulty in storing electricity for sunless days.

Another reason the sun is extremely important is that it provides the energy needed for green plants to make food. Inside the leaf cells of a green plant is a green substance called chlorophyll. Chlorophyll enables leaf cells to use the energy from sunlight to chemically combine carbon dioxide with water to form sugars. This process is called photosynthesis. A byproduct of photosynthesis is oxygen, which is given off into the air. Therefore, sunlight enables green plants, which are the basic food sources of living things and the major sources of oxygen in the earth's atmosphere, to carry out their essential activities.

The sun also helps people find directions. Since the earth rotates from west to east, the sun seems to move across the sky from the east to the west. Though the exact places where the sun "rises" and "sets" depend

on the time of year, the sun's location is sufficiently stable to be used as a crude direction finder.

Telling the time is another reason why the sun is important. The first clocks were, in fact, sundials.

### Chapter 3: The planets, pages 257-271

Unlike stars, planets are solid bodies. Also, planets do not give off their own light. Instead, they are observable only because they reflect sunlight. There are nine known planets, including the earth, that orbit the sun.

The orbit, or the path, of each planet is somewhat oval, rather than circular. So the distance each planet is from the sun varies from time to time. Besides orbiting the sun, each planet also rotates around an imaginary axis that runs through its centre.

The earth differs from the other planets in several important ways. First, only the earth is known to be occupied by living things. Also, only the earth has an oxygen-rich atmosphere, contains water and receives the proper amount of sunlight for plant growth and habitable temperatures.

Like the other planets, the earth revolves around the sun and rotates on an imaginary axis. But the time required by the earth to do so varies from that of the other planets. The earth rotates once approximately every twenty-four hours, or one full day on the earth. Since the earth is a sphere, about half of that time is spent in darkness and half in sunlight.

It takes the earth about 365 days, or one year on the earth, to revolve around the sun. As the earth revolves around the sun, the angle at which sunlight strikes it continually changes. This happens because the earth's axis is slightly tilted.

In winter, the northern hemisphere is tilted away from the sun. So the sunlight strikes the northern half of the world at an angle, resulting in cool temperatures. Also, there are fewer hours of daylight. In fact, certain parts of the Arctic are in darkness for about six months every year.

In summer, the northern hemisphere is tilted towards the sun. So the sunlight strikes the northern half of the world more directly, resulting in warm temperatures. Also there are more hours of daylight.

In the spring and fall, the sunlight strikes the northern hemisphere less directly than in summer.

Astronomers have studied the other planets with telescopes and space vehicles. The conditions found on other plants are quite different from those found on earth.

The planet Mercury is closest to the sun, and so Mercury is often hard to observe. Mercury can be seen near the horizon just after sunset or just before sunrise during certain times of the year. Pictures received from space vehicles show that the surface of Mercury is pockmarked with craters. Mercury's closeness to the sun causes its daytime temperatures to reach about 329°C.

Venus, which is the next in the order of planets moving outward from the sun, is enveloped in a dense cloud cover. This cloud cover reflects sunlight so well that, except for the sun and the moon, Venus is the brightest object in the sky. Venus is about the size of the earth and may have a surface of mountains and deserts. However, little water or oxygen is thought to be present. In addition, the average temperature on Venus is 427°C.

Next in order is Earth and beyond Earth is Mars. Mars has a reddish appearance caused by the dust that covers most of the planet. Winds blow almost continually on its surface. There is evidence of volcanoes and of seasonal changes. The average daily temperature on Mars is −62°C. However, the temperature varies greatly from one area of Mars to another. For example, near Mars' equator the temperature may reach 21°C during the day, but other areas may not exceed −23°C during the day. Of all the planets, Mars is thought to be most like the earth. However, there seems to be no water on Mars, and recent space probes have failed to discover any evidence of life.

The next planet in order from the sun is Jupiter. Jupiter is the largest known planet. It is more than ten times larger than the earth. Jupiter seems to have no water or oxygen. Moreover, it is thought that Jupiter's atmosphere contains poisonous gases.

Beyond Jupiter is another giant planet, Saturn. It too seems to have an atmosphere of poisonous gases, and probably no water or oxygen. Saturn is easily distinguished from the other planets by thin rings that surround it. The rings are thought to consist of small chunks of ice and possibly rocks of varying sizes. Our knowledge of Saturn will increase tremendously during the next few years from the data that has been collected during the Pioneer Space Program.

The three most-distant planets in order from the sun are Uranus, Neptune and Pluto. Their remoteness makes it difficult to study many of their features. Neptune and Pluto are the only planets that cannot be seen without the aid of a telescope. Because of their remoteness, Neptune and Pluto might not have been discovered had scientists not been looking for them. Scientists noted that certain unexplained gravitational forces were affecting the orbit of Uranus. The scientists concluded that there must be other unknown planets. Therefore by using mathematical computations, the scientists were able to predict the area in space in which a planet or planets should be. The scientists, using telescopes, searched the area until they discovered Neptune and then Pluto.

### Chapter 4: The moon, pages 272-277

The moon is the only natural body that orbits the earth. At an average distance of 384 000 km, the moon is much closer to the earth than to any other planet.

The moon has no water or atmosphere, so there is no wind or weather to affect the surface of the moon. The moon's surface is largely composed of jagged moun-

tains and smooth plains. Its surface is also pitted with numerous craters. The craters may be the remains of extinct volcanoes. A thick layer of dust particles and scattered rocks also cover its surface.

Like the planets, the moon shines because it reflects sunlight from its surface. Because the moon is a sphere, only half of its surface is struck by sunlight at one time.

As the moon orbits the earth, different amounts of its lighted surface can be observed. The changes in the amount of lighted surface people see are called the phases of the moon. The phases of the moon result from the position of the moon with respect to the positions of the earth and the sun.

For example, during the new-moon phase, the moon is between the sun and the earth. Therefore, no sunlight is reflected from the moon toward the earth. The entire cycle involving the phases of the moon takes about thirty days.

Like the earth, the moon rotates on an imaginary axis. However, the moon rotates only once about every thirty days. Since it also takes about that amount of time for the moon to orbit the earth, people always see the same side of the moon.

Both the earth and the moon cast a long shadow into space as sunlight shines on them. When the moon passes directly between the sun and the earth, the moon's shadow falls on a small portion of the earth's surface. For the people living in the area of that shadow, the sunlight is eclipsed, or blocked. An eclipse of this kind is called a solar eclipse. A solar eclipse does not happen often because the moon's shadow usually passes slightly above or below the earth.

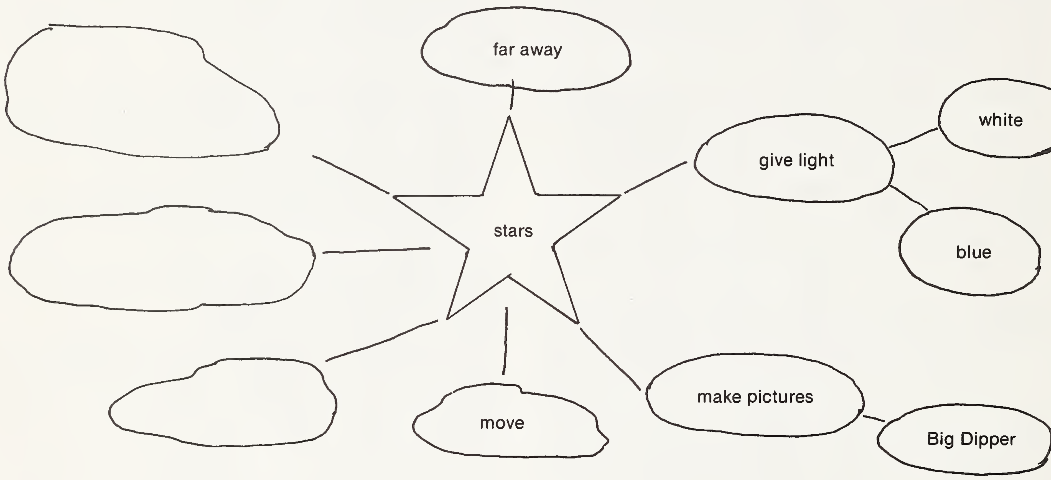
Sometimes the earth passes directly between the sun and the moon. Then the earth's shadow falls on the moon, blocking the sunlight. When this occurs, there is no sunlight to reflect from the moon's surface, resulting in what is called a lunar eclipse.

## TEACHING STRATEGIES

The purpose of the following activities and teaching strategies is to provide you, the teacher with a wide variety of suggestions that can be used, together with the material presented in the textbook, to develop the processes and concepts of this unit.

### Introduction

— Following a discussion of the cartoon on page 241, the students' understanding about stars might be shared in a session of semantic mapping around the term stars.




— Leave the map in view in order that additional material may be recorded during the study.

### Chapter 1: A sky full of stars, pages 242-250

— In order that the students realize that there are many, many stars in the universe, have them go outdoors on a clear night and count stars. Have them use wax paper rolls in order that they may view small sections of the sky at one time. The colour of the stars can be *observed* and the size of the stars can be *compared*.

— Worksheet 1 can be used to record the number of stars in each section viewed.

— Another method of creating interest in the stars is to have the students locate the Big Dipper and then Polaris, the North Star. Worksheet 2 gives directions for finding these stars.

### What are stars?, (page 243)

— Stars are composed of the gases hydrogen (about 75%), helium (about 22%) and other gases including oxygen, neon, carbon and nitrogen.

— Worksheet 3 shows the student how information can be presented in different ways.

— A darkened gymnasium and two extension cords

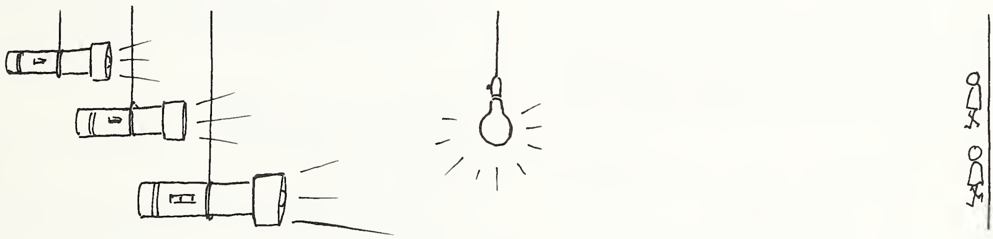
with the same wattage light bulbs can be used to demonstrate to the students that the same amount of light will appear brighter if it is located much nearer the viewer.

— The students can be directed to make inferences about light and distance.

**"Finding Out" (page 244)**
**Why are most stars seen only at night?**

— You may wish to have your students complete Activity 35 in their Activity Books (Textbook page 244).
*Sample answers:*
1. It disappeared.
2. I could see the light better. Because as I moved the "sun" farther away from the wall, its light got dimmer.
3. Because the sun's light is too bright and blocks the light from other stars.

— A modification of the "Finding Out". (page 244) is to:
- Hang flashlights at one end of a darkened room
- Place a bright lamp in the middle of the room
- Locate the children at the far end of the room



What happens to the starlight when the sun appears?

**"Finding Out" (page 245)**
**How can you make light twinkle?**

— You may wish to have your students complete Activity 36 in their Activity Books (Textbook page 245).
*Sample answers:*
1. A small circle of light.
2. It moved back and forth. Because warm air from the hot plate caused the light to move.

**Why are stars different colours? (page 246)**

— The colour of a star indicates the temperature of its surface. Worksheet 4 will help students realize the colour of a star depends on how hot it is.

**Why do stars seem to move?**

— Much of the movement of stars we view is caused by the rotation of the Earth. Discussion about the movement of the Earth and the stars can be generated following:
(a) Locating the position of the Big Dipper in the evening and again just before sunrise. (See Worksheet 2)
(b) Plotting shadows that the sun casts on the playground early in the school day and just before dismissal in the afternoon.
— How has the position of the shadows changed?
— What has moved?

— Worksheet 5 explains how a sky viewer might be used to map the stars.

**What are constellations? (page 247)**

— See the Teacher's Edition (page 247) for an activity that helps students to learn about constellations. A two litre milk carton can be used in place of the shoe box.

— To find some of these constellations in the night sky or the early morning sky should be a great delight for the students.

— The early morning is best for viewing the night sky because there is usually less local light at that time.

**Chapter 2: A special star, pages 251-256**

— The sun's diameter of 1,400 000 km rates this star as medium-sized. Worksheet 6 provides an opportunity for students to compare the size of some stars and to think of the sun as a medium-sized star.

— Some students may be asked to find the actual diameters of stars other than the sun. This information is not usually readily available.

**"Finding Out" (page 252)**
**Why is the sun important? (pages 253-255)**

— Students should be cautioned against looking directly at the sun.

— Worksheet 7 provides an opportunity for the students to consider the heat from the sun.

— The students must *observe* the ice sample in the three locations, *measure* the time accurately, *record the data* and make an *inference* based on their observations.
*Sample answers:*
1. The closer star. Because it is closer to me.
2. Because it is the closest star to the earth.

— Following reading and discussion of page 254 the

investigation provided on Worksheet 8 might be carried out by the children.

— **Note:** Young plants may thrive for some time in a dark area. Mature potted plants are more reliable if available.

— In order to investigate how the sun might be used to tell time, students might complete Worksheet 12 that asks them to consider the location and the length of shadows at different times of the day.

— These activities have the students *recording data*, making *inferences* about the time and the location of shadows and *hypothesizing about the changing behavior of the sun over a year.*

— The activity that has students measuring shadows can be extended over several weeks or months. E.g.
 — Have the students measure the length of their shadows at the same time each day or once a week for several months. The student must stand on the same spot each time and the time, the day and the length of the shadow must be recorded each time. The students will soon realize their shadows are getting shorter or longer.

### "Finding Out" (page 256)
### How can you make a sundial?

— You may wish to have your students complete Activity 38 in their Activity Books (Textbook page 256).
*Sample answers:*
1. Answers will vary.
2. Because the shadow of the nail was pointing to that number on the cardboard.
3. The sun shines from different parts of the sky at different times during a day, so the shadow of the nail is in different places on the cardboard during a day.
4. Because sundials do not show the time on cloudy days or during the night.

## Chapter 3: The planets, pages 257-271

### Stars or plants (pages 257-258)

— The concept that planets are bodies that move around the sun and are seen because sunlight shines on them can be demonstrated in a darkened gymnasium.

— A model can be developed as follows:
1. the sun (an illuminated light bulb or a lamp) can be located in the centre of the room.
2. Planets consisting of marbles, small balls or any small round dark object can be carried in orbit about the sun by the students.
3. On the outer fringes of the gymnasium, students can stand holding small lights that would represent the stars beyond our solar system.

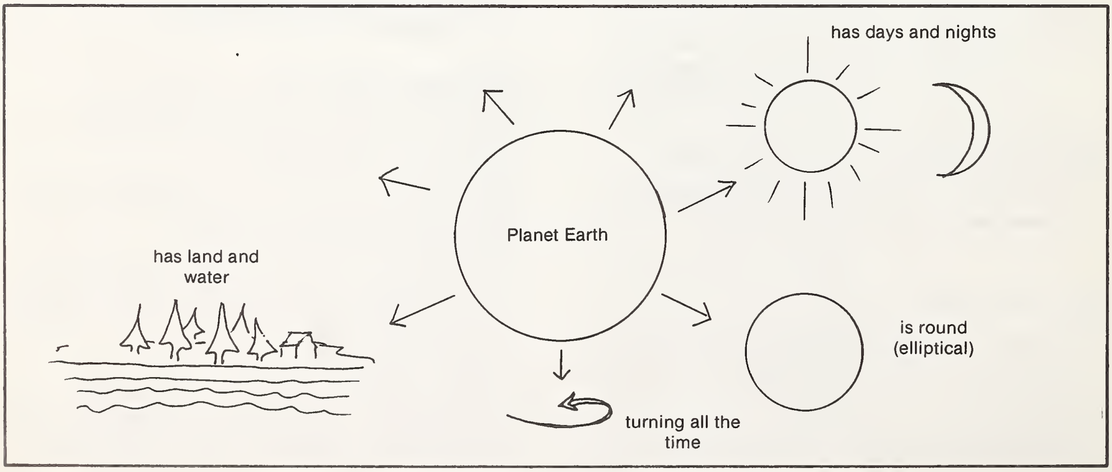
— Distance and size is misconstrued in such a model but the basic concept can be discussed and viewed.

### How planets move (pages 258-259)

— After reading and discussing pages 258-259, students might construct the model suggested in the teacher's edition (page 258) to compare the size of the planets and their distance from the sun.

### "Finding Out" (page 260)
### What would happen if a planet stopped moving around the sun?

— You may wish to have your students complete Activity 39 in their Activity Books (Textbook page 260)
*Sample answers:*
1. It went around in a circle.
2. It stopped moving and fell toward the ground.
3. The "planet" would swing slower. The "planet" would swing faster.



## The earth is a planet (pages 260-262)

— In order to introduce the planet earth, you might have the class engage in a semantic mapping exercise that will have them providing "their" information about the planet earth:

— 1. Print PLANET EARTH in the centre of a blackboard or a large piece of paper.

— 2. Have the students tell what they know about the earth.

— 3. The information is noted in the form of a web.

— 4. This web of information is kept in view for the duration of the study and may be added to or altered as new information is learned.

— Worksheet 10 may be used to have students research the earth. A sharing of information may help some students after all resources have been exhausted.

## "Finding Out", (page 263)
## How can you show what causes day and night?

— You wish to have your students complete Activity 40 in their Activity Books (Textbook page 263).

*Sample answers:*

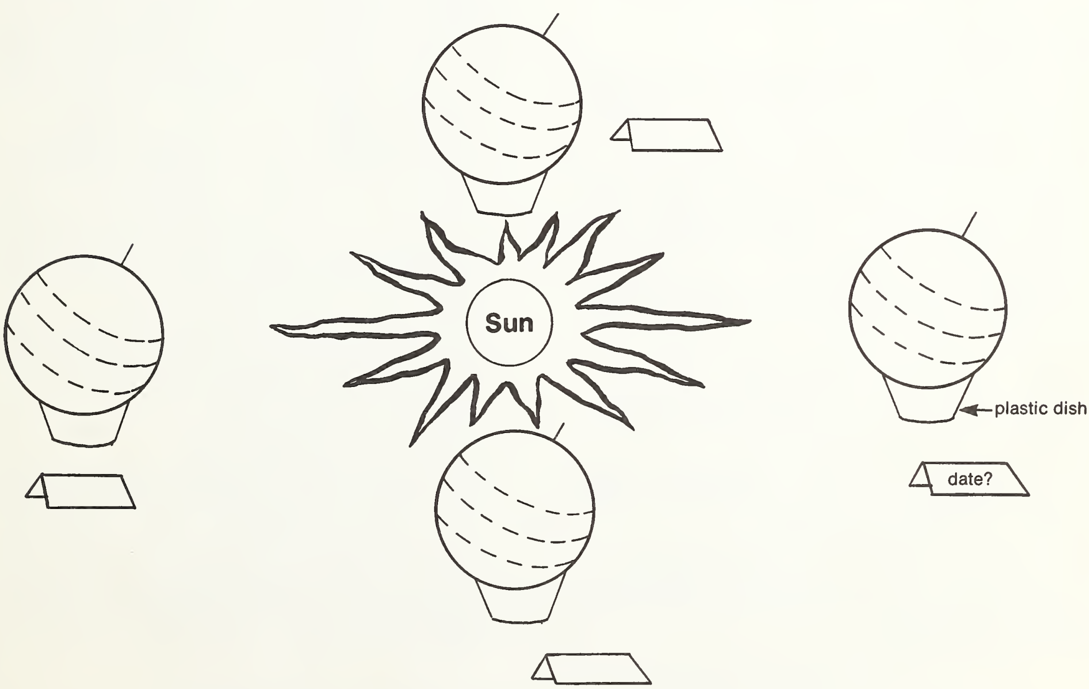
1. It was in darkness for half a turn. Because the whole earth cannot be lighted by the sun all the time.
2. When the earth travels in its orbit, it tips each pole toward the sun for about six months. During the time a pole tips toward the sun, it has daytime. During the time a pole tips away from the sun, it has darkness.

— If this model can be available to the students over a period of time the concept of seasons and year as described on pages 264-265 can be developed effectively.

## Years and seasons (pages 262-265)

— A model that will help students understand the seasons of the year can be set up in the classroom as follows:

1. Place four large balls (volleyballs are good) on four plastic dishes about a mounted, lighted globe.
2. Glue a gold tee to the top of each ball and ring the ball with masking tape in order that the Equator and the Tropics of Cancer and Capricorn can be marked on the tape.
3. Tilt the ball 23½° off the perpendicular and add as much information as desired.



### "Finding Out" (page 265)
### How can you show what causes seasons?

— You may wish to have your students complete Activity 41 in their Activity Books (Textbook page 265).
*Sample answers:*
1. The bottom part has summer. Because this part is leaning toward the "sun", it is warm.
2. The top part has winter. Because this part is leaning away from the "sun", it is cool.
3. The top part. Because it is leaning toward the "sun."
4. The bottom part. Because it is leaning away from the "sun."
5. Halfway between the point at which it leaned away from the sun and the point at which it leaned toward the sun.
6. Halfway around the sun from the point at which it had spring.

— Worksheet 11 may be used to further the understanding of students concerning the seasons of the year. This worksheet may be very challenging for some students.

### Other planets (pages 266-271)

— Students may find it fun to structure wordings that will help them remember the name of the planets on Worksheet 12.

— Following the reading and discussion of pages 266 to 271, the students might be asked to name the planets described on Activity Cards 1-1 to 1-9.

### The Disgruntled Planets

— An activity that the students should enjoy has them writing a play about the problems of a disgruntled group of planets.

— A group of ten students write a play in which the nine planets complain to the Sun, who is the King, about their location in the solar system. Each planet in turn describes his problem to the Sun. Some of the things they want corrected include:

Mercury: I am always cold. I want to move closer to you, my King.
Earth : Jupiter won't talk to me.
Pluto : I want to be off by myself.
Saturn : I am lonely. I want some close neighbours.
Jupiter : My days are too long.

— Each planet must prepare what it wants to say remembering that it is really asking to be located where it is presently positioned.

— The Sun must listen to each complaint and in the finale the Sun decries his solution for each problem. The planets end up in the positions they hold today.

Additional suggestions:
1. Each student may write his own lines or groups of students may work on a common script.
2. Two or three different groups can perform their version of the skit.
3. Students can make simple costumes to depict the planet they represent.
4. The parents might enjoy the play.

— Each planet has special features that set it apart from other planets. Using information found on pages 266-270 students can complete Worksheet 13 that describes what a spacecraft passing close to the planets might signal back to Earth.

— Some students could prepare tape recordings of what they think an astronaut, in a spacecraft passing close to the planet, might say in order to describe how the planet looks.

### Chapter 4: The Moon, pages 272-277

— The moon, the only natural satellite of the earth, orbits the earth once in approximately 29½ days.

— Organize a "moon watch". On a night that the moon is in view in the early evening, plan to meet with your students to view the moon together. Have the students bring binoculars with them to view the moon. Things to observe and discuss might include:
- The surface features of the moon.
- The position of the sun in relation to the moon.
- Why a part of the moon is in darkness.
- How the moon is like the earth.
- How the moon is like other planets.

### What is the moon? (pages 273-274)

— Worksheet 14 has students using data and mathematics to determine the distance and the travel time to the moon and other planets. Some students may attempt to determine the travel time to the nearest star, other than the sun Proxima Centauri is 4.3 light years from earth. A light year is approximately 9 408 000 000 000 km.

— The lunar rover carried the astronauts across the dusty lunar surface. After studying the moon's surface as shown in the picture on page 273 and other pictures of the moon's surface that can be obtained, have the students design a lunar rover that would best suit travel on the lunar surface.

— Students may research the lunar rover used by the Apollo 15 astronauts and try to draw a detailed drawing of this famous lunar rover, as an alternative to designing their own machine.

— Students can investigate the origin of craters on the moon by doing Worksheet 15.

— Students can measure the craters created from different heights and discuss their observations. Students will *observe* the craters created. Careful *measurement* must be taken and *comparison* made. *Inferences* can be based on observations. Then, a general statement can be *hypothesized* about the craters on the moon.

### Seeing different shapes, page 274

— The shape of the lighted part of the moon should be

observed and charted by the students over a period of time. A classroom record of the phases of the moon might be kept in place of individual student charts. See Worksheet 16.

— The suggested activity explained in the Teacher's Edition (page 275) might take place in a darkened gymnasium and be modified as shown in the diagram.

— Worksheet 17 may be used to expand on the concept of an "eclipse". The eclipse of the moon is demonstrated and discussed.

"Finding Out", (page 276)
**What happens when the moon passes directly between the sun and the earth?**

— You may wish to have your students use Worksheet 25.

*Sample answers:*

1. The "moon" blocked most of the light from the "sun" so that the whole "sun" could not be seen from the earth.
2. The earth would block the sun's light so that the moon could not be seen from the earth, causing an eclipse of the moon.

"Finding Out", (page 277)
**How can you show why you see only one side of the moon?**

— You may wish to have your students use Worksheet 26.

*Sample answers:*

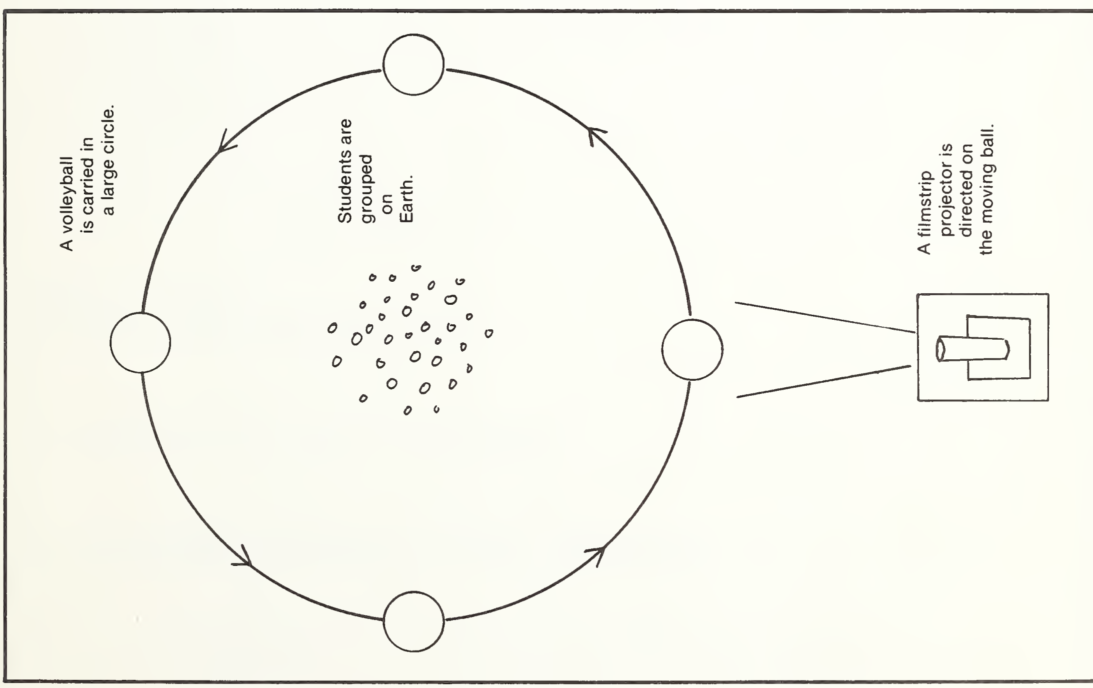
1. Yes.
2. Because the moon takes as long to turn around its axis as it does to travel around the earth.
3. To see both sides, the moon must not go around its axis. Have the "moon" face the same wall while walking around the "earth."

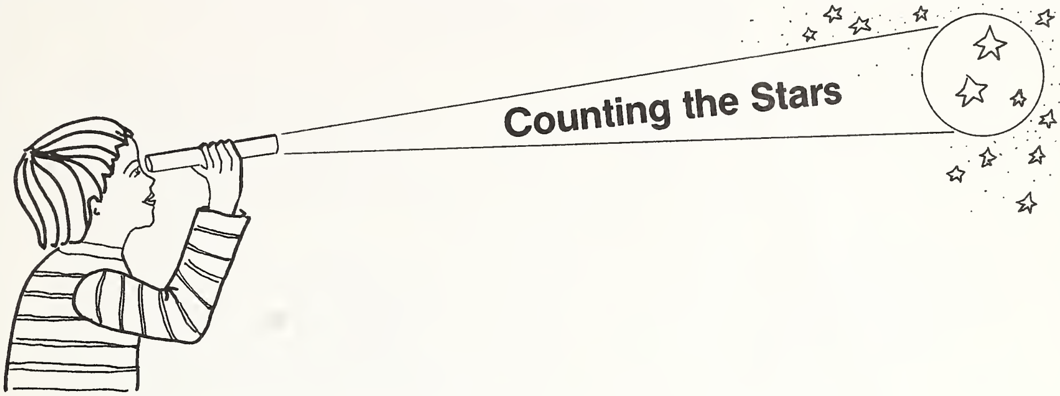
Workers Who Use Science, (page 278)

— Following the reading and discussion of the information on page 278, the roles of the astronaut and the astronomer can be considered further by the students when they complete Worksheet 18.

— Students should be given the opportunity to view the night sky through a telescope if at all possible.

— Perhaps a local person who is knowledgeable about astronomy can come to the classroom to tell the students about the night sky.





# Counting the Stars

You will need: an empty paper roll
the record sheet

How to proceed:

1. Investigate the night sky through the tube.
2. Point your tube directly overhead and hold it very steady.
3. Count the number of stars you see through the tube.
4. Record the number of stars you can count.
5. Swing the tube to several other parts of the sky and count the stars you view in each position.
6. Record each count.

| Number of stars viewed: | | |
|---|---|---|
| Position No. 1 | ______ | ______ |
| Position No. 2 | ______ | ______ |
| Position No. 3 | ______ | ______ |
| Position No. 4 | ______ | ______ |
| Position No. 5 | ______ | ______ |
| Total number of stars | ______ | ______ |

For class discussion:

1. How many stars did each person view?

2. How might we count every star in the night sky?

3. What is another way we might count the stars in the night sky?

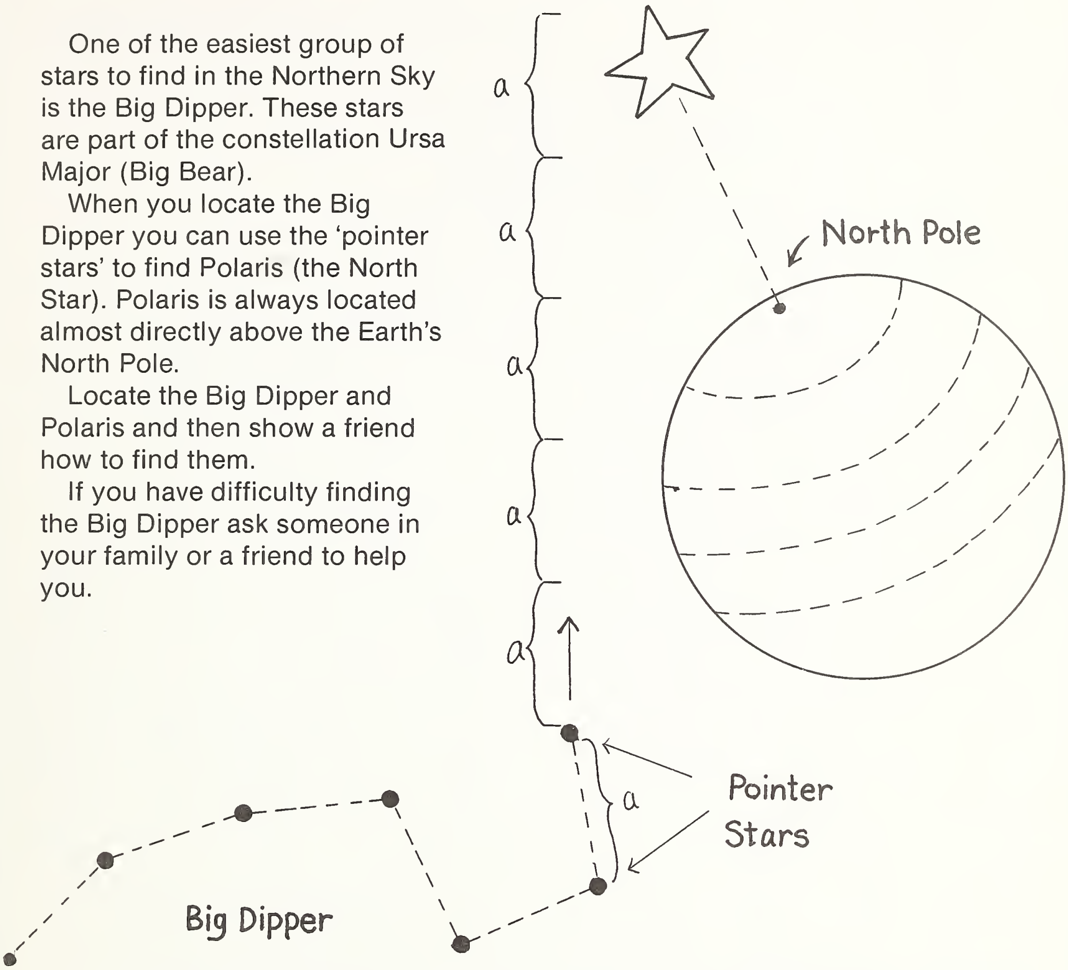
# LOCATE POLARIS

One of the easiest group of stars to find in the Northern Sky is the Big Dipper. These stars are part of the constellation Ursa Major (Big Bear).

When you locate the Big Dipper you can use the 'pointer stars' to find Polaris (the North Star). Polaris is always located almost directly above the Earth's North Pole.

Locate the Big Dipper and Polaris and then show a friend how to find them.

If you have difficulty finding the Big Dipper ask someone in your family or a friend to help you.




Question to think about and discuss:

How can the North Star help us find our direction?

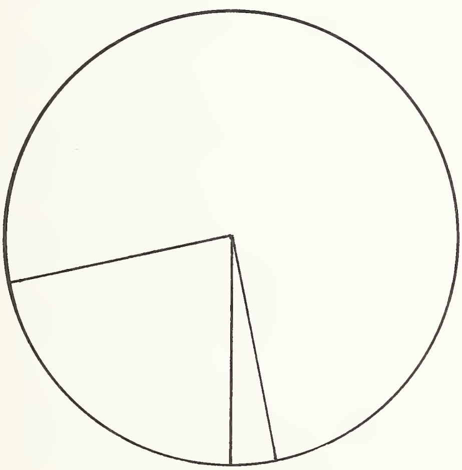
# Composition of a Star

Here are three ways to show what stars are made of:

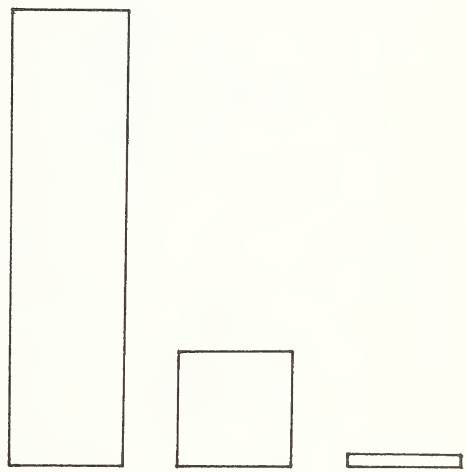
For every 100 parts in a star:
75 parts are the gas hydrogen
22 parts are the gas helium
3 parts are other gases

Complete the three graphs shown below:

1. name the parts of the graphs
2. colour the parts of the graphs
   hydrogen — green
   helium — blue
   others — red



Composition of a Star



Composition of a Star

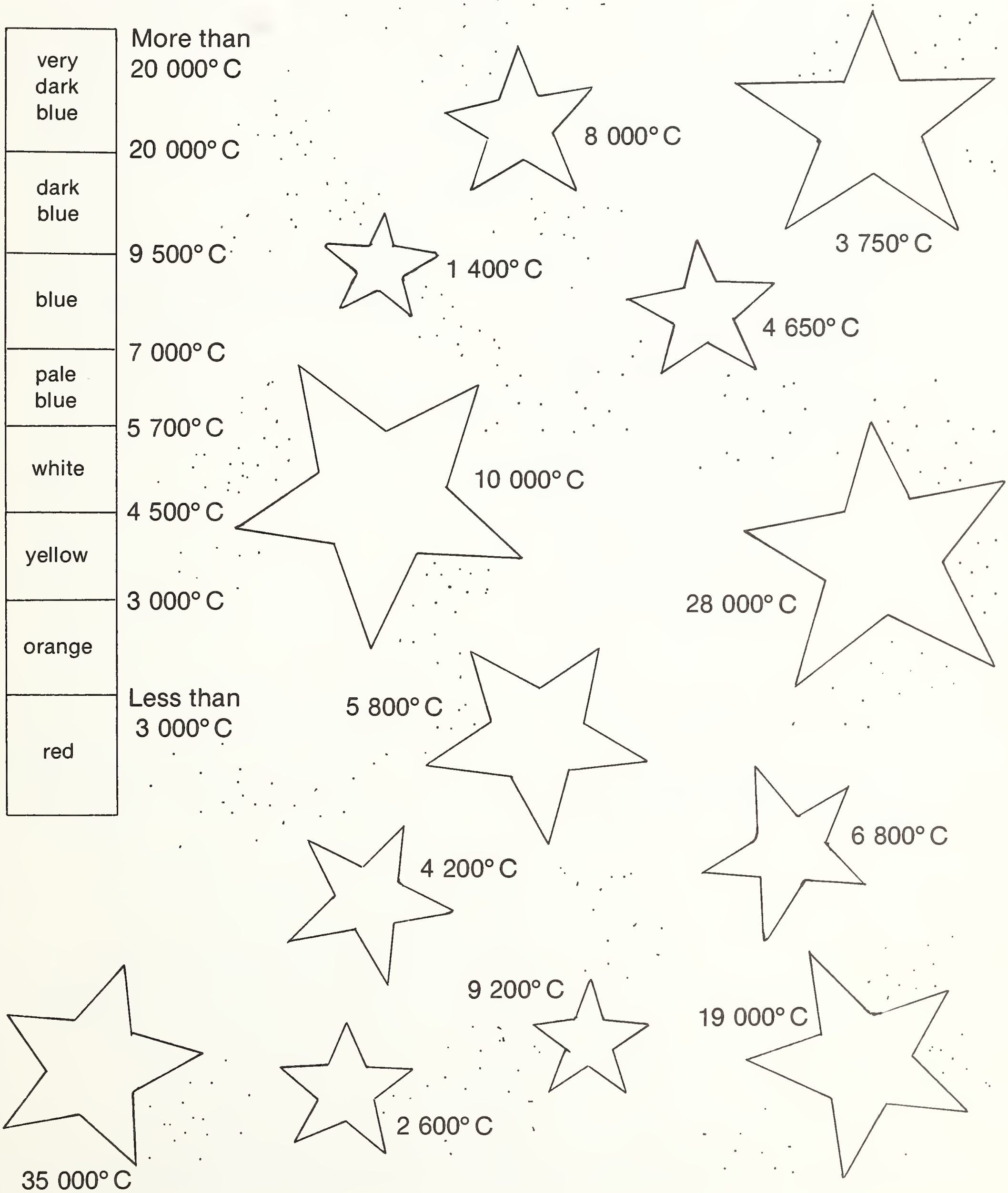
Composition of a Star

Can you develop another way to show the composition of a star?

# Hot Hot

Colour the stars using the colour code provided:

| Colour | Temperature |
| --- | --- |
| very dark blue | More than 20 000° C |
| | 20 000° C |
| dark blue | |
| | 9 500° C |
| blue | |
| | 7 000° C |
| pale blue | |
| | 5 700° C |
| white | |
| | 4 500° C |
| yellow | |
| | 3 000° C |
| orange | |
| red | Less than 3 000° C |

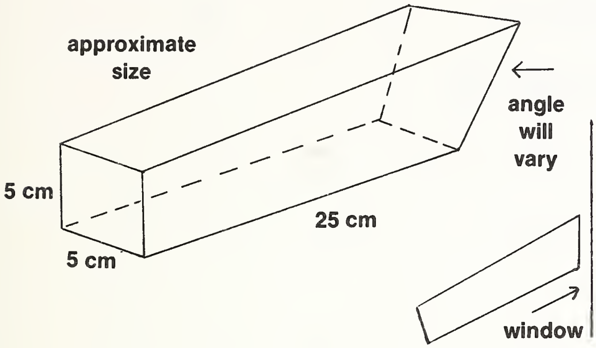



Watching the Sky, Worksheet 4

# Mapping the Stars

View a section of the sky at different times during the evening using a sky viewer.

1. Construct your star viewer of cardboard.




2. Place your viewer against the window after dark and map the stars you see looking through the viewer.

3. Thirty minutes later place your viewer in the exact same position and map the stars you see.

4. Repeat this picture thirty minutes later.

5. Take your pictures to school to discuss them with the class.

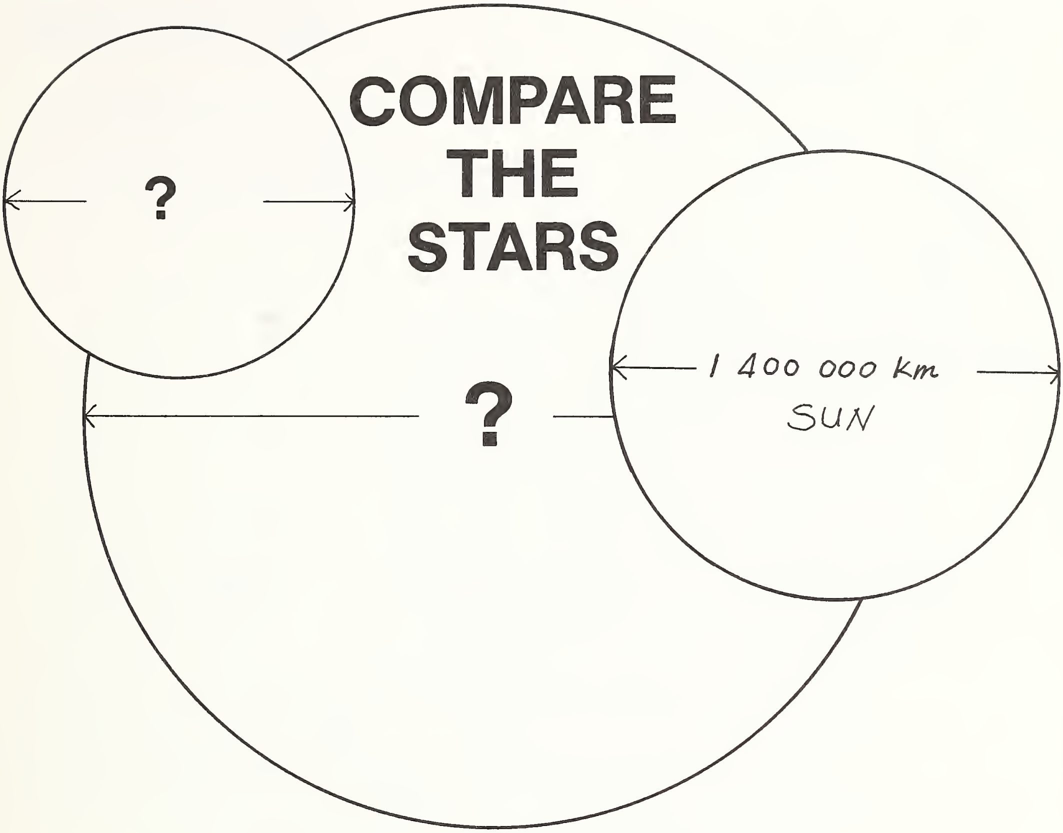
Questions to discuss:

1. How are the maps of the stars different?

2. How might we explain the movement of stars?

3. Would the maps change if we viewed the stars another night at the same times?

# COMPARE THE STARS

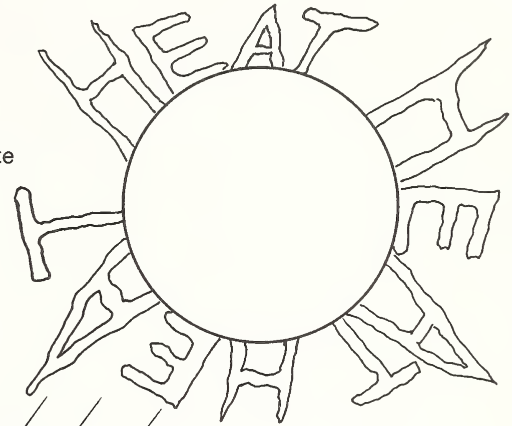



Find the size of other stars using the sun's diameter.

1. Star A's diameter is 800 000 km greater than the sun's diameter.
   ________________ km
2. Star B is five times the size of the sun.
   ________________ km
3. Star C is one-half the size of the sun.
   ________________ km
4. Star D is one hundred times the size of the sun.
   ________________ km
5. The diameter of Star E is 60 000 km less than the sun.
   ________________ km
6. Star F is one quarter the size of the sun.
   ________________ km
7. Star G is almost the same size as the sun.
   ________________ km
8. Star H is one-half the size of Star B.
   ________________ km

Calculations:: $\div$ $+$ $\times$ $\frac{x}{?}$

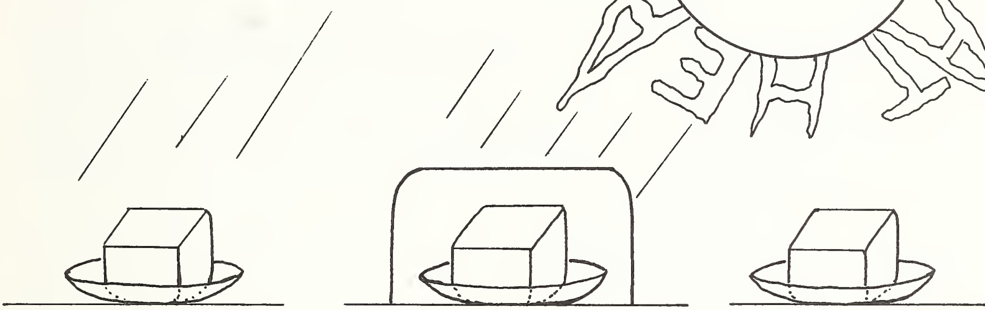
# INVESTIGATION




Investigate the heat from the sun.

You will need: 3 ice cubes; 3 saucers

- Place three ice cubes all the same size on separate saucers in three different locations.



(a) in direct sunlight (b) in the shade (c) indoors

- Measure the time it takes for each ice cube to melt completely.
- Record the time in each case.
- Repeat the investigation and record the times once again.

| | DIRECT SUNLIGHT | IN THE SHADE | INDOORS | |
|---|---|---|---|---|
| TIME | | | | |
| | | | | |

I learned ______________________________

______________________________

______________________________

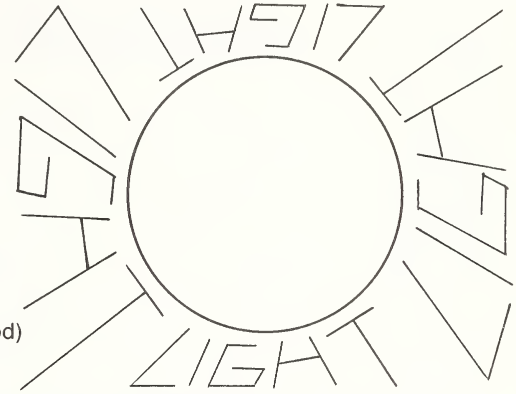
______________________________

______________________________

______________________________

______________________________

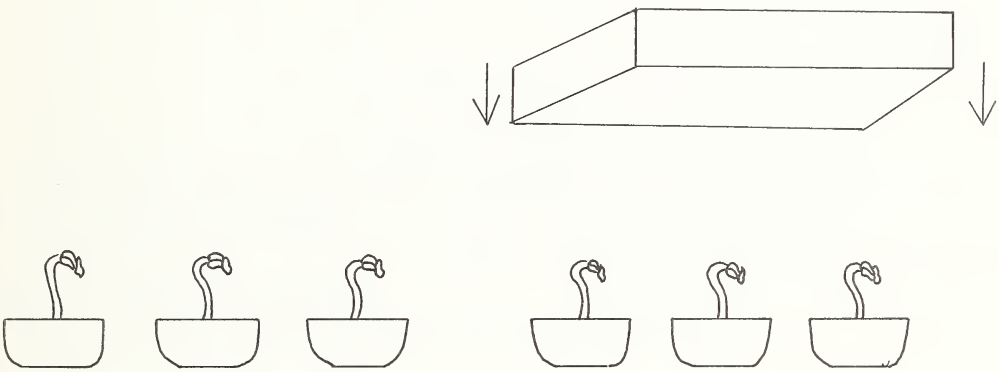
# INVESTIGATION




Investigate how the light from the sun will affect the growth of plants.

You will need: some bean seeds,
6 empty plastic containers

- Plant some seeds (scarlet runner beans are good) in containers. Water regularly and place in the sunlight.
- When the new plants have sprouted to a height of 15 to 20 cm place one-half the pots under a carton.



Continue to water each plant daily.

- Observe the growth of the plants for a period of two weeks.
- How are the plants growing differently?

1. What did you observe while carrying out this investigation?

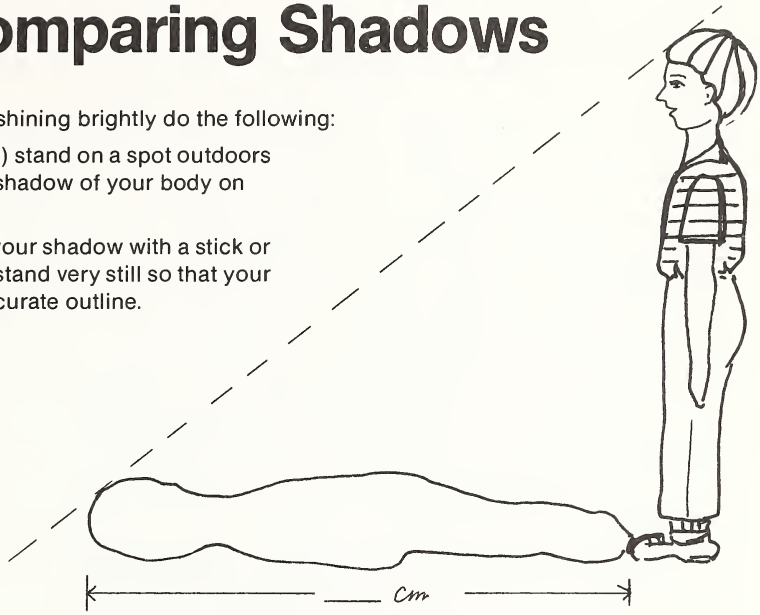
2. What can you conclude from the investigation?

Did sunlight help the plants grow?

# Comparing Shadows

On a day when the sun is shining brightly do the following:

- At a set time (10:00 a.m.) stand on a spot outdoors so that the sun casts a shadow of your body on the ground.
- Have a partner outline your shadow with a stick or a piece of chalk. Try to stand very still so that your partner can draw an accurate outline.




- Draw an outline of your partner's shadow at another spot away from your outline.
- Later in the day (2:00 p.m.) stand on the same spot as in the morning and have your partner draw your shadow once again.

**Questions to think about and discuss:**

1. How is your 10:00 a.m. shadow different from your 2:00 p.m. shadow?

2. Are your two shadows the same length? Why?

- If possible draw your shadow at a later time (6:00 p.m.)

How has your shadow changed?

Tell the class the next day.

# PLANET EARTH

## Information to Find

1. shape of the earth ................ ____________
2. age of the earth .................... ____________
3. distance from the sun ............ ____________
4. length of a year ..................... ____________
5. 'circumference' of the earth ......... ____________
6. human population ................. ____________
7. earth's nearest neighbour ........... ____________
8. time of one 'rotation' ............. ____________
9. diameter of the earth .............. ____________
10. average temperature on earth ....... ____________
11. tilt of the earth ....................... ____________
12. most important item on the earth .... ____________

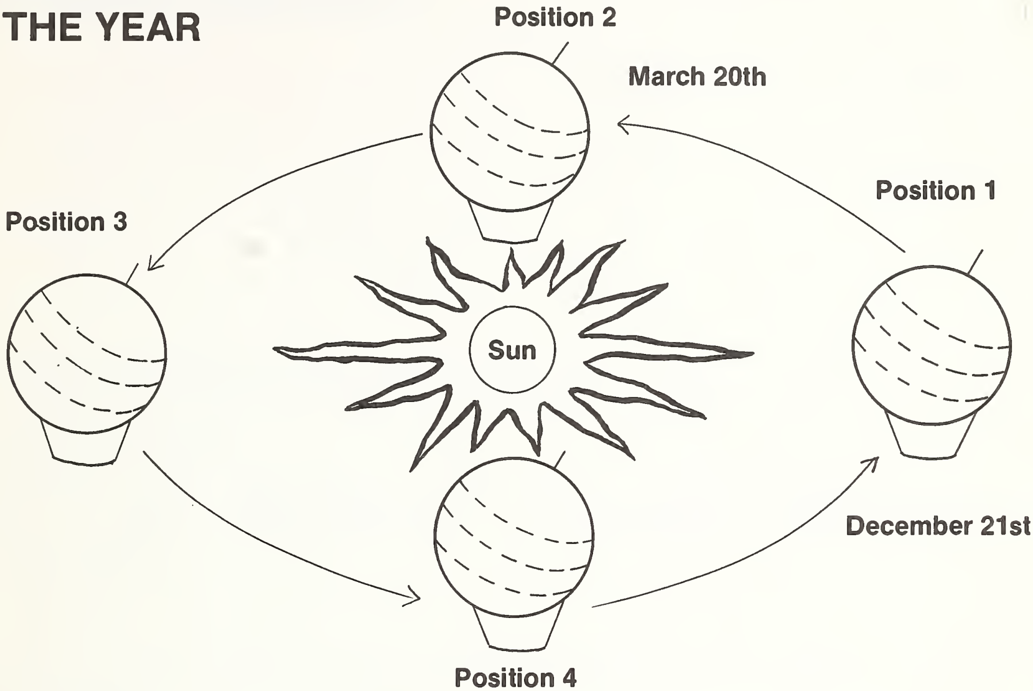
Where I found my information:

____________

____________

____________

# SEASONS OF THE YEAR




This model of the sun and earth shows us why we have four seasons. Study the model and answer the questions listed below:

1. Position 1 shows the location of the earth on December 21st. What is the date of Position 3?

   ______________________________

2. When the earth is in Position 2 the mid-day sun is directly over the equator. Over what point on the earth is the mid-day sun directly above in Position 3?

   ______________________________

3. Which position shows the earth on September 22nd?

   ______________________________

4. The sun is directly above the Tropic of Capricorn in Position __________

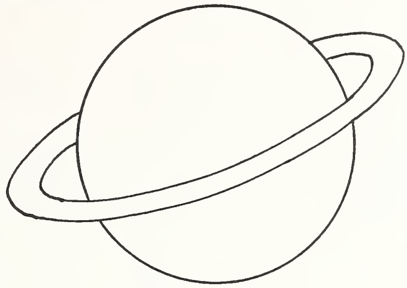
5. For people in the Northern Hemisphere the overhead sun is farthest away at what date?

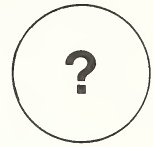
   ______________________________

6. In Position 4 the mid-day sun is directly above the

   ______________________________

# Planet Names?






Help yourself remember the names of the planets.
Prepare a 'wording' that will help you remember.

Here is a sample:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Mercury | Venus | Earth | Mars | Jupiter | Saturn | Uranus | Neptune | Pluto |
| My | very | eager | monkey | just | swallowed | Uncle | Ned's | Pipe. |

Now you try:

______ ______ ______ ______ ______ ______ ______ ______ ______

Try another:

______ ______ ______ ______ ______ ______ ______ ______ ______

Make a set of cards.

- Print one word of your wording on each card.
- Lay the cards face down on the desk and scramble them well.

How long will it take your friend to unscramble your cards and read your wording?

The dry red planet has volcanoes and dry channels possibly caused by running water in the past . . .

____________________

The outer most planet in our solar system is also the smallest and the coldest planet . . .

____________________

Countless ice particles circle this second largest planet in rings . . .

____________________

A rapidly spinning ball of gas is the largest planet of our solar system. Its red spot is a high pressure storm . . .

____________________

The only planet known to have living things has an atmosphere of oxygen, nitrogen, carbon dioxide, and water . . .

____________________

A heavily cratered and airless planet is closer to the sun than any planet in the solar system...

______________________

This far-away planet shines with a blue-green colour because of its atmosphere of methane gas. It is similar in size to Neptune...

______________________

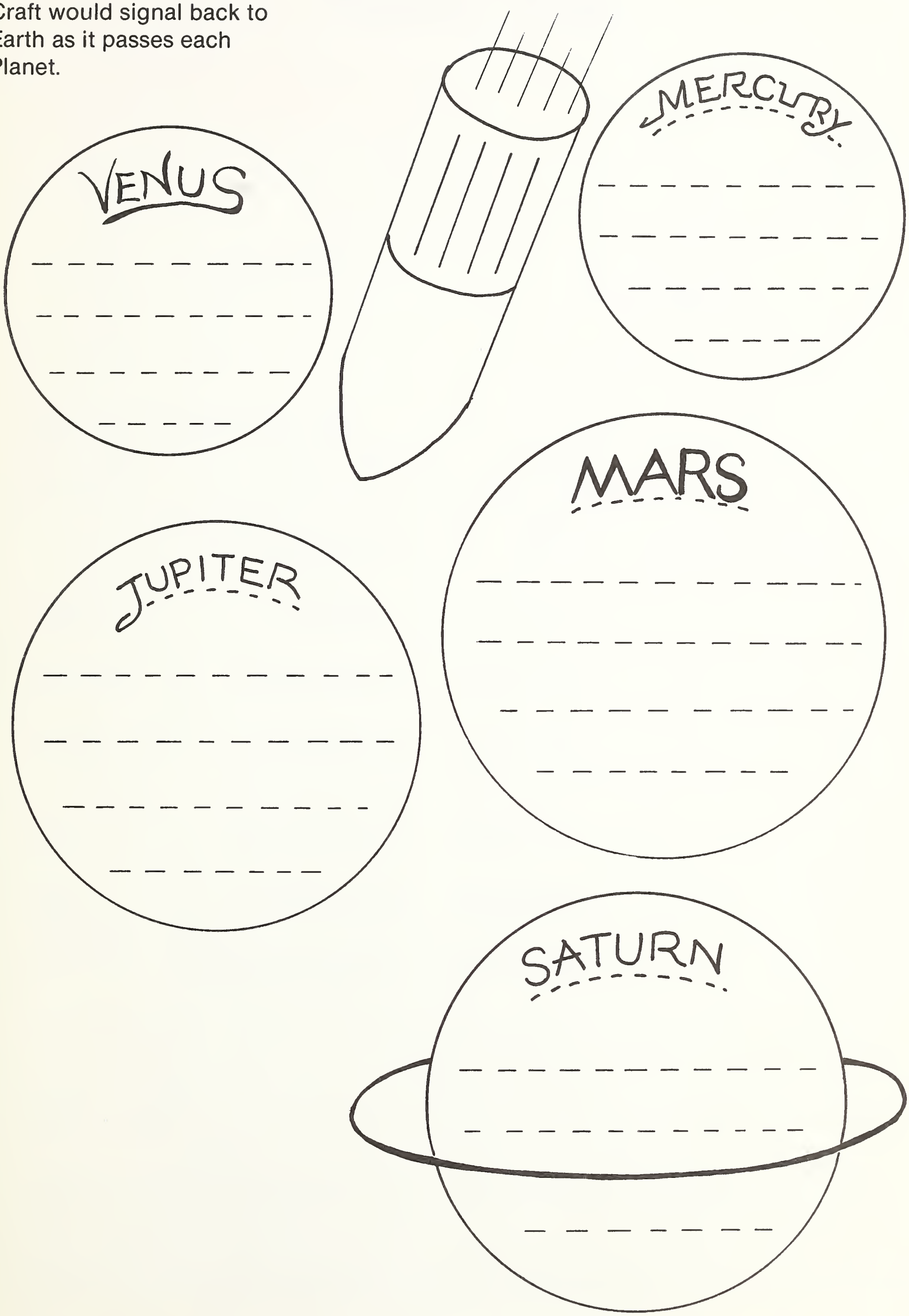
A twin in size to the earth, this planet has a heavy layer of cloud hiding its surface...

______________________

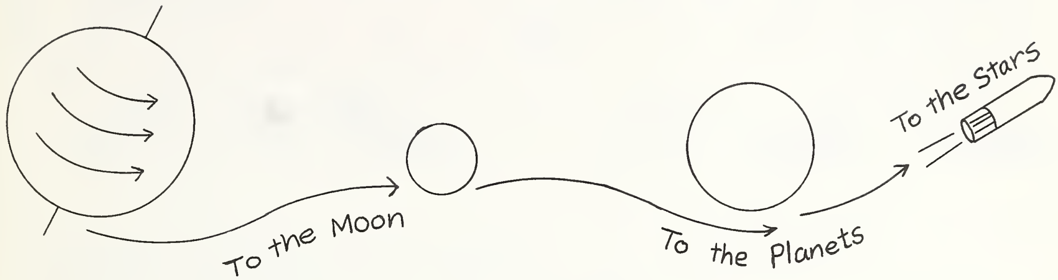
This distant planet, a twin of Uranus in size, can only be seen by telescope...

______________________

List words that the Space Craft would signal back to Earth as it passes each Planet.



# Travel Time




How long will it take to travel to:

the moon? the planets? the stars?

| | DISTANCE FROM EARTH | SPEED | TRAVEL TIME HOURS | DAYS |
|---|---|---|---|---|
| Moon | 380 000 km | 20 000 km/h | ______ | ______ |
| Mercury | 93 000 000 km | 20 000 km/h | ______ | ______ |
| Venus | 43 000 000 km | 20 000 km/h | ______ | ______ |
| Jupiter | 625 000 000 km | 20 000 km/h | ______ | ______ |
| Saturn | 1 276 000 000 km | 20 000 km/h | ______ | ______ |
| Sun | 150 000 000 km | 20 000 km/h | ______ | ______ |
| Proxima Centauri | 40 000 000 000 000 km (4.3 light years) | 20 000 km/h | ______ | ______ |
| ______ | ______ | ______ | ______ | ______ |
| ______ | ______ | ______ | ______ | ______ |
| ______ | ______ | ______ | ______ | ______ |
| ______ | ______ | ______ | ______ | ______ |
| ______ | ______ | ______ | ______ | ______ |

# CREATING CRATERS

To investigate the making of craters on the moon.

You will need: a tray, sand or dry soil, rocks of varying sizes

- Fill a pan or a carton bottom with dusty soil mixed with sand (don't pack the soil)
- Select stones approximately 1 cm, 2 cm and 3 cm in diameter.
- Drop one of the stones from varying heights into the soil (30 cm, 60 cm, 90 cm, 120 cm)
- Observe the craters formed each time the stone is dropped
- Measure the diameter of the crater formed each time the stone is dropped

Questions for Discussion:

1. Do the craters change when the height of the drop is increased?

2. Is any soil thrown out of the craters when the rocks hit the soil?

3. Would different types of soil provide different types of craters? (investigate)

4. How big are some of the craters in the pictures on page 266? (the diameter of the moon is about 3540 km)

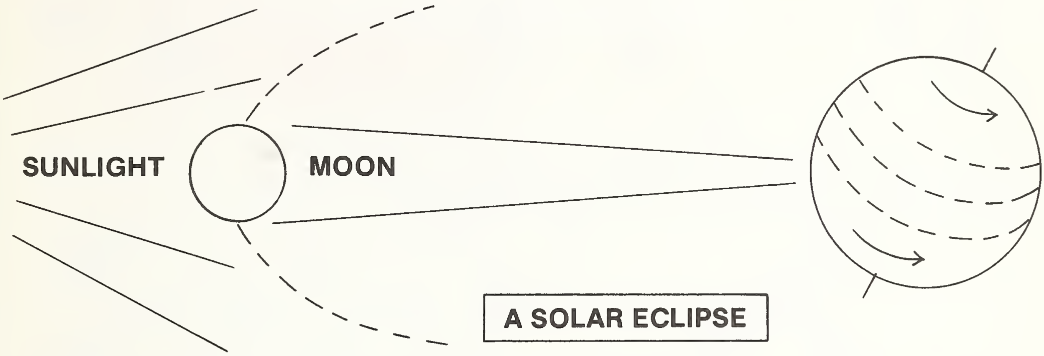
# MY MOON CALENDAR

1. Keep a record of the shape of the moon every day it appears.
2. If it is cloudy draw a cloud in the space.
3. Colour the shape.

**MONTH** ____________

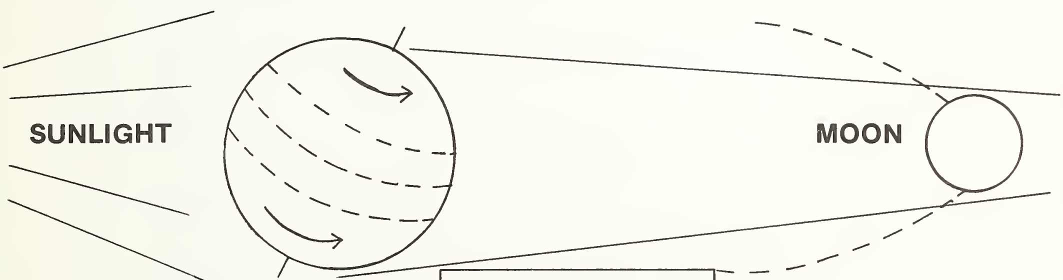
| SUNDAY | MONDAY | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY | SATURDAY |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

# SOLAR ECLIPSE LUNAR




A SOLAR ECLIPSE

These three things happen during an eclipse of the sun.




A LUNAR ECLIPSE

These three things happen during an eclipse of the moon:

# Who Would Know?


Which of these two people would you ask the following questions:

1. What is the size of Jupiter? ........ ____________________
2. How to land a space vehicle? ....... ____________________
3. What is the temperature of the sun's surface ...................... ____________________
4. When is the best time to start a trip to the moon?................ ____________________
5. How to walk in space? ........... ____________________
6. What does the far side of the moon look like? ................. ____________________
7. When a certain comet will appear? .. ____________________
8. How to hit a golf ball on the Moon? ...................... ____________________
9. How to use a radio telescope? ...... ____________________
10. How to eat when you are weightless? ..................... ____________________

Watching the Sky, Worksheet 18

The Exploring Science Program